# EXPANDED ENGINEERING EVALUATION/ COST ANALYSIS FOR PHASES I AND II OF THE SILVER CREEK DRAINAGE PROJECT

**Lewis & Clark County, Montana**

**Prepared For:**

**Mr. Vic Andersen and Mr. Ben Quiñones**
**Montana Department of Environmental Quality**
**Remediation Division**
**Mine Waste Cleanup Bureau**
**2209 Phoenix Avenue**
**P.O. Box 200901**
**Helena, Montana 59620**

**Prepared By:**


**Olympus Technical Services, Inc.**
**765 Colleen**
**Helena, Montana 59601**


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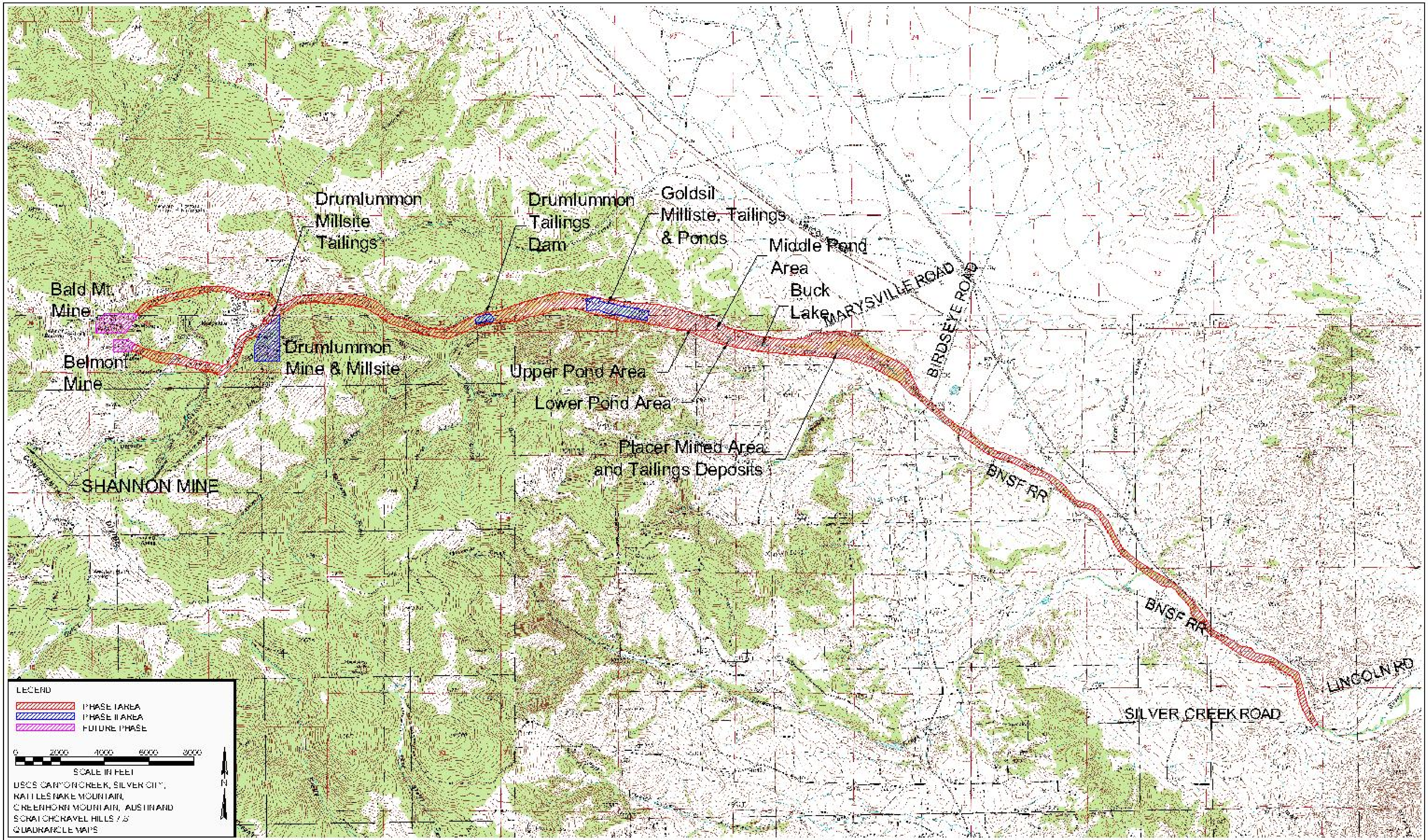
# 1.0 INTRODUCTION

The Silver Creek Drainage Project is located approximately 15 miles north of Helena, Montana. The headwaters of the basin are located on the east side of the Continental Divide near the historic mining community of Marysville and the project encompasses a portion of the Marysville Mining District. This document presents the Expanded Engineering Evaluation and associated Cost Analysis for the reclamation of the abandoned tailings, waste rock piles and placer tailings included in Phases I and II of the Silver Creek Drainage Project. The data used for this evaluation was presented in the Phase I and Phase II site characterization reports for the Silver Creek Drainage Project (DEQ-MWCB/Olympus, 2003a and 2003b) prepared by Olympus Technical Services, Inc. (Olympus) and submitted to the DEQ-MWCB in February 2003. The project area includes the Drumlummon mine, millsite and tailings areas, the Goldsil millsite and tailings areas, the Upper, Middle and Lower Pond areas, the Silver Creek placer tailings area and the Silver Creek stream corridor (Figure 1-1). The Goldsil millsite and Drumlummon mine/mill/tailings are currently ranked No. 5 and 45, respectively on the Montana Department of Environmental Quality, Mine Waste Cleanup Bureau (DEQ-MWCB) Priority Sites List.

The Silver Creek Drainage Project extends from the headwaters of Silver Creek located above Marysville to where the Burlington Northern & Santa Fe Railway intersects Silver Creek Road (Figure 1-1). Phase I of the Silver Creek Drainage Project included reconnaissance level characterization of the Silver Creek streambed, streambanks and floodplain area (excluding the known waste sources at the Bald Mountain, Belmont and Drumlummon mines and the Drumlummon and Goldsil tailings piles), the Jennies Fork streambed, streambanks and floodplain, and the large area of placer tailings upstream from Birdseye Road. Phase II of the project included characterization of the known waste sources at the Drumlummon mine and the Drumlummon and Goldsil tailings piles. Known waste sources from the Bald Mountain and Belmont mines will be characterized during Phase III of the Silver Creek Drainage Project in 2003.

The project area is located in Lewis & Clark County, Montana within Sections 35 and 36, Township 12 North and Range 6 West; Sections 31, 32, 33 and 34, Township 12 North, Range 5 West; Sections 1, 2, 3 and 5, Township 11 North, Range 5 West; and Sections 6, 7, 8, 16, 17, and 21, Township 11 North, Range 4 West, Montana Principal Meridian (Figure 1-1). This figure shows the approximate boundaries of the project and the location of Phases I and II of the characterization. Figure 1-2 is a composite of aerial photographs taken in 1995 showing an overview of the Silver Creek Drainage Project area. More detailed aerial photographs are presented to show the Marysville and Drumlummon Mine areas (Figure 1-3), Silver Creek above Sawmill Gulch (Figure 1-4), Drumlummon and Goldsil tailings areas (Figure 1-5), the Goldsil Millsite and Upper, Lower and Middle Pond Areas (Figure 1-6), the Buck Lake and the upper Silver Creek placer tailings areas (Figure 1-7), the lower Silver Creek placer tailings area (Figure 1-8), Silver Creek Below Birdseye Road (Figure 1-9), Silver Creek through the upper portion of the Gehring Property (Figure 1-10), Silver Creek through the lower portion of the Gehring Property (Figure 1-11) and lower Silver Creek near Silver Creek Road (Figure 1-12).

Field Sampling, Laboratory Analytical and Quality Assurance Project Plans for Phase I and Phase II were prepared for the site in July 2002 (DEQ-MWCB/Olympus, 2002a, 2002b, 2002d and 2002e). These documents outline the sampling and analytical methods used to generate the site characterization database. The site characterization work was performed during the summer and fall of 2002. The Site Characterization Reports present the data with the following evaluations:

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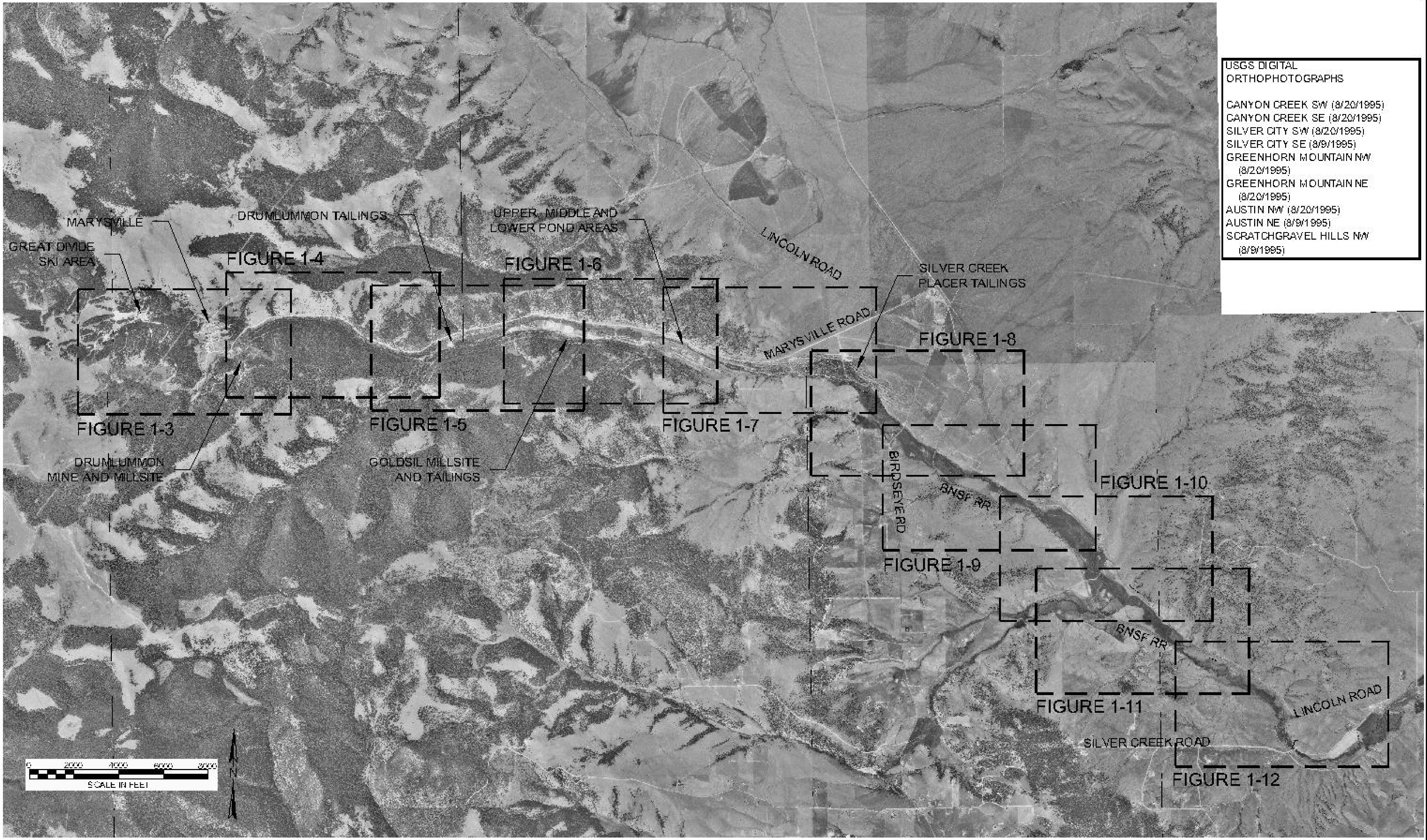
MONTANA DEQ/MINE WASTE CLEANUP BUREAU
SILVER CREEK DRAINAGE PROJECT
LEWIS & CLARK COUNTY, MONTANA

**Olympus Technical Services, Inc.**

SILVER CREEK DRAINAGE
PROJECT OVERVIEW MAP

FIGURE
1-1

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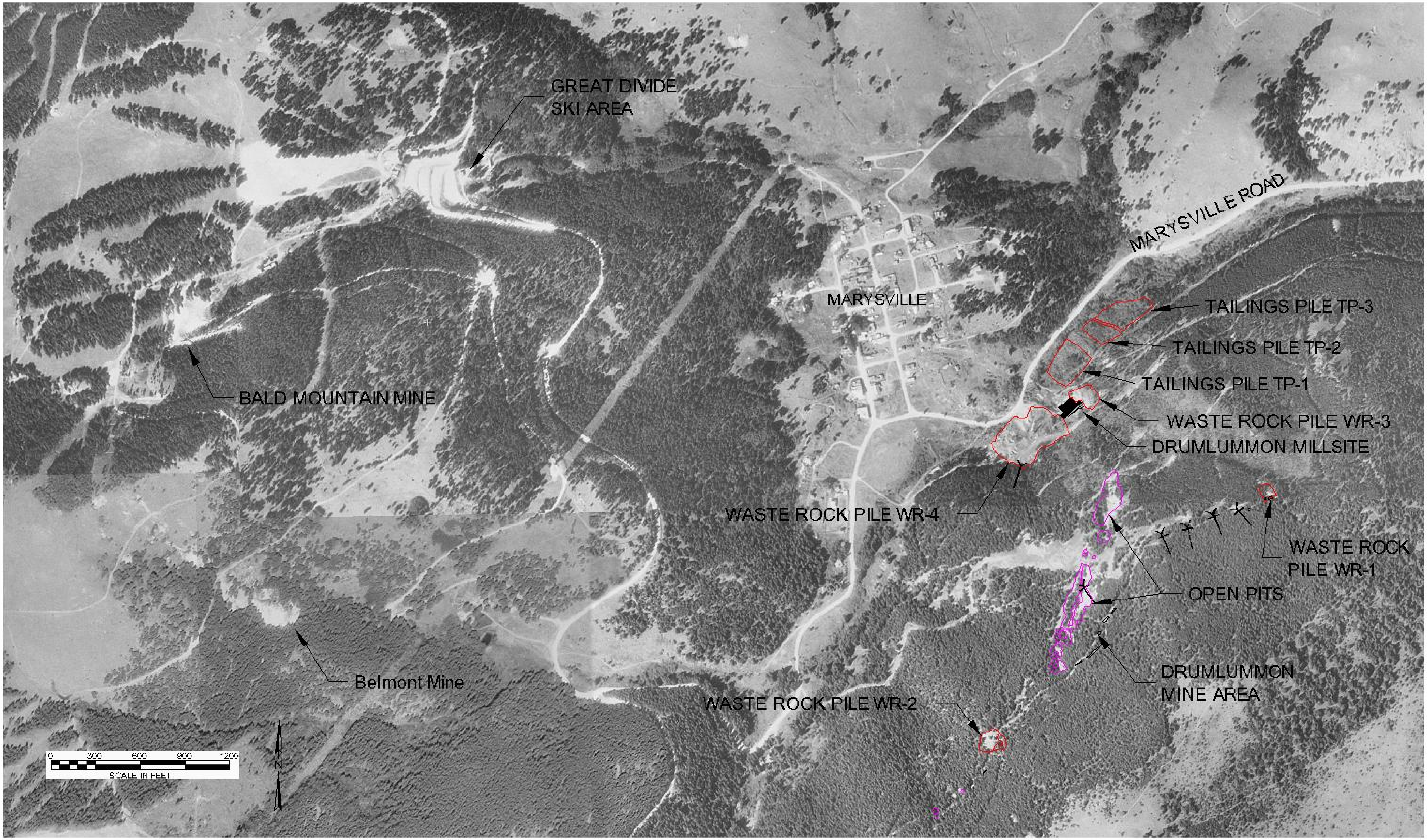
AERIAL PHOTOGRAPH OF THE SILVER CREEK DRAINAGE

FIGURE 1-2

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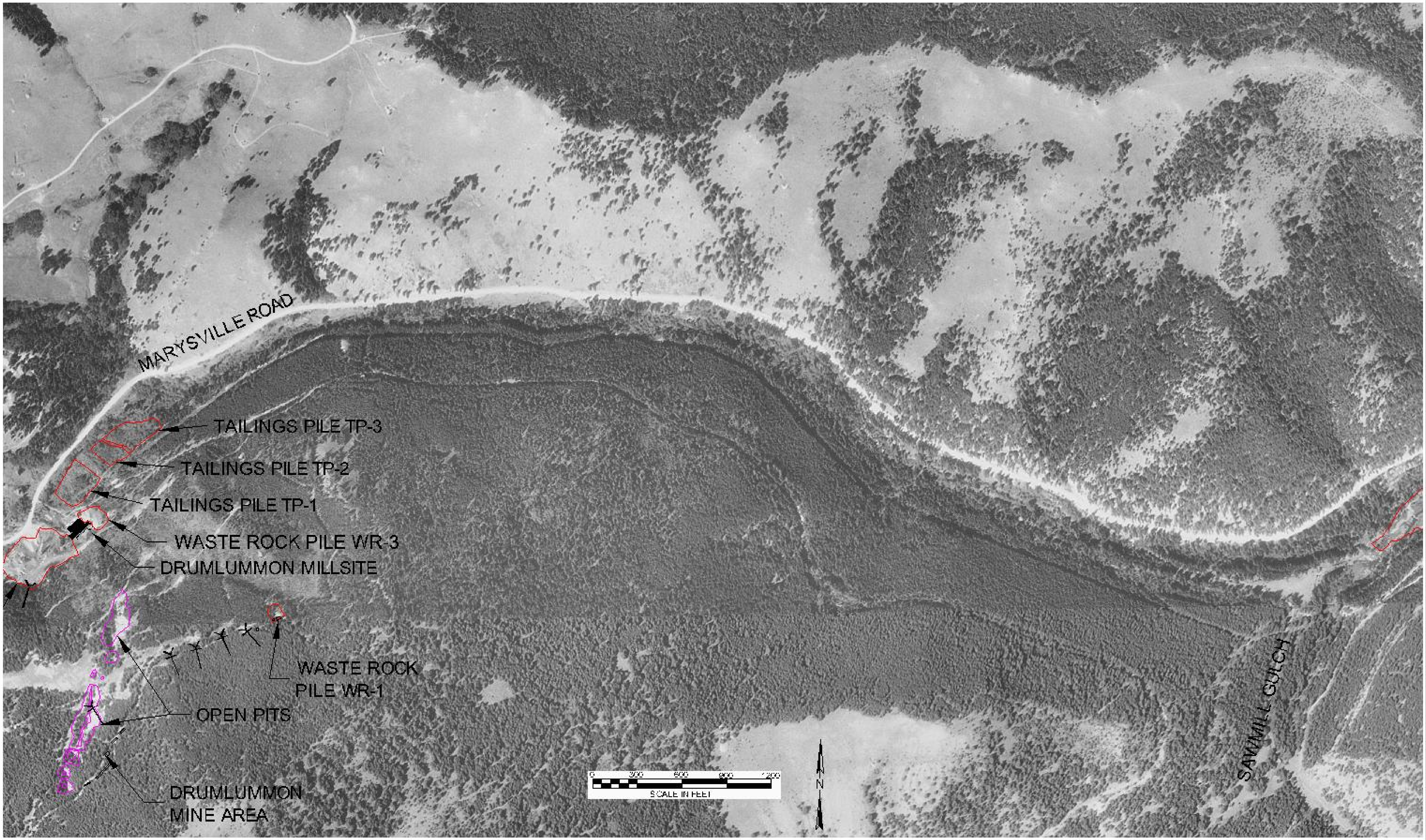


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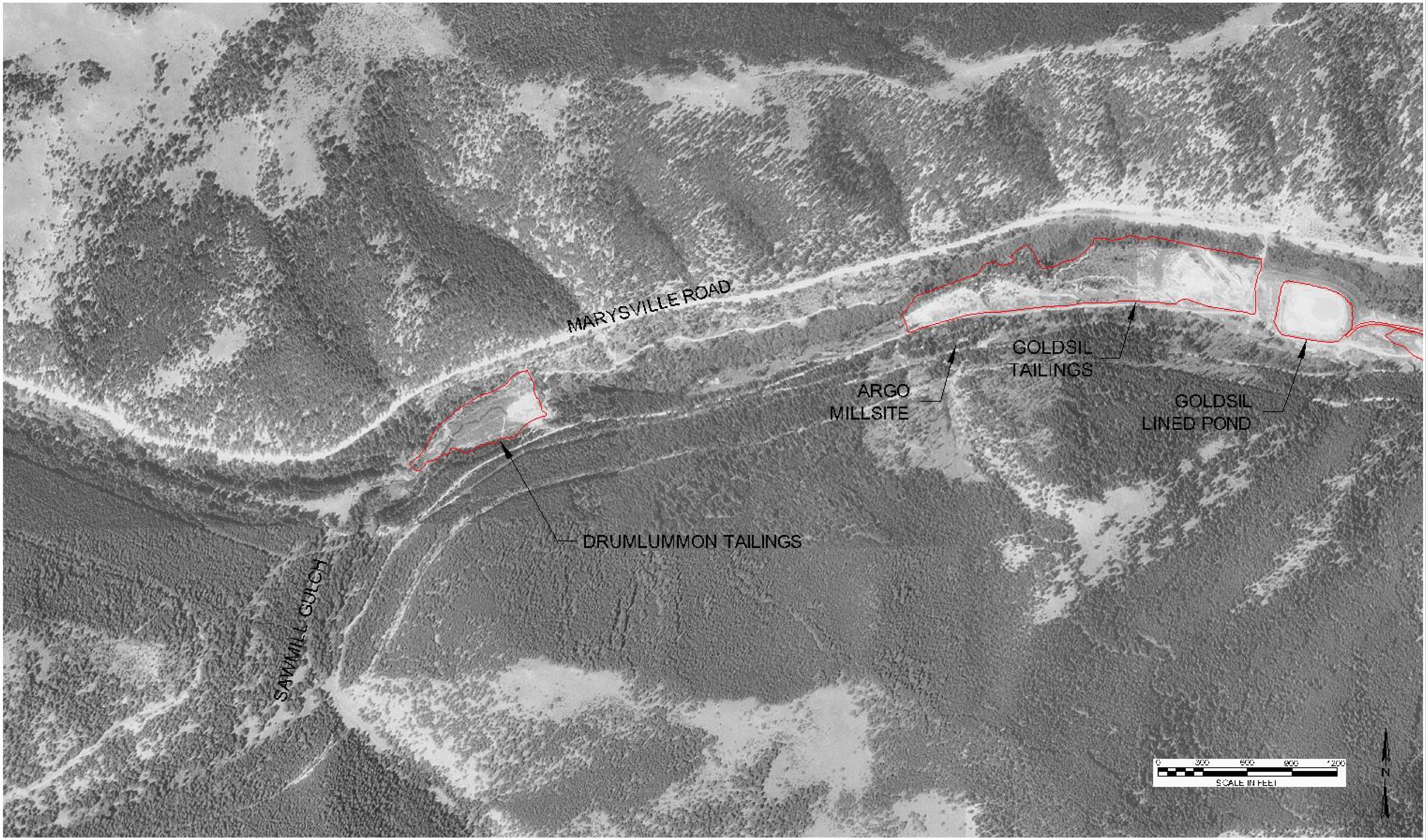
SILVER CREEK ABOVE
SAWMILL GULCH

FIGURE
1-4

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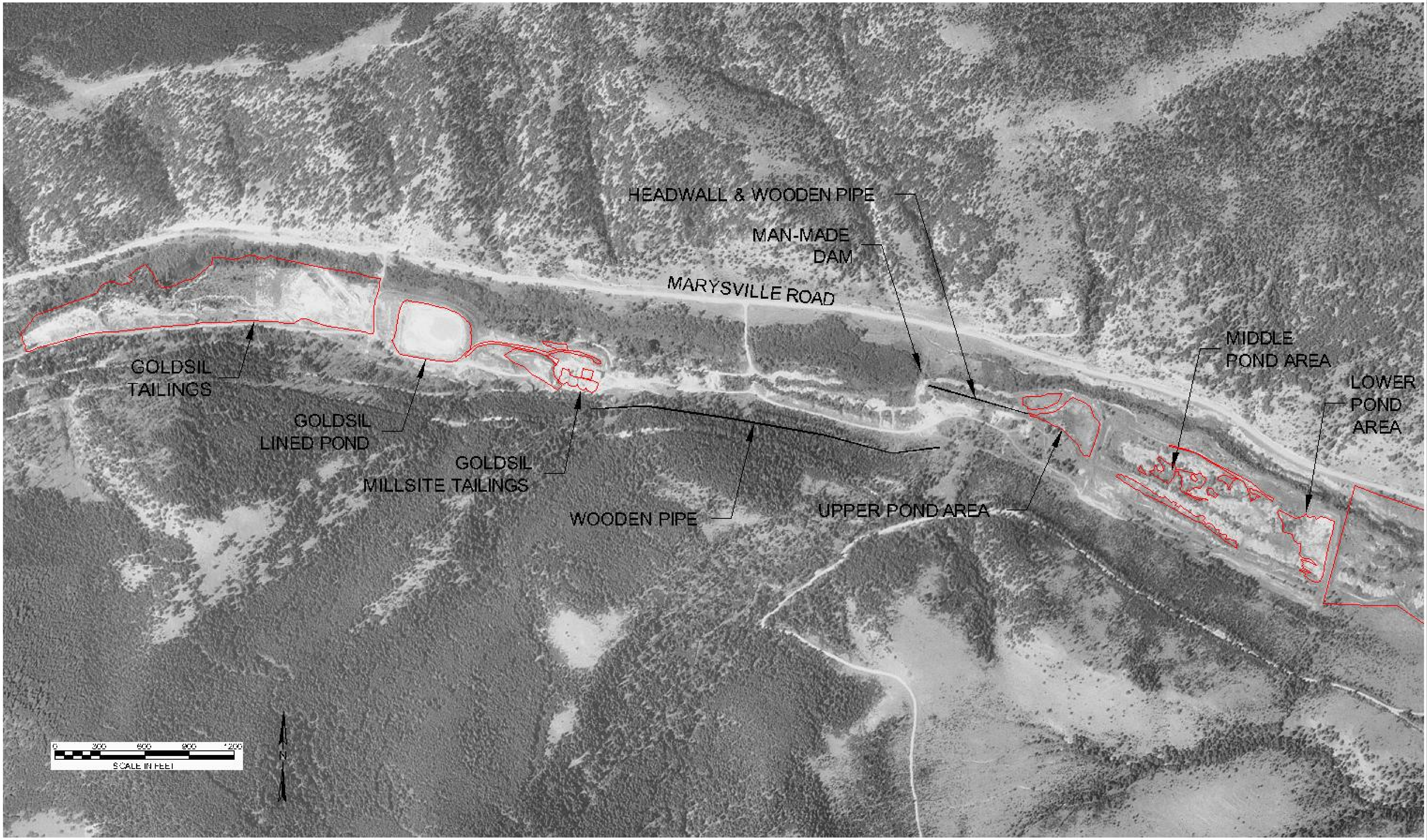


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MONTANA DEQ/MINE WASTE CLEANUP BUREAU
SILVER CREEK DRAINAGE CHARACTERIZATION
LEWIS & CLARK COUNTY, MONTANA

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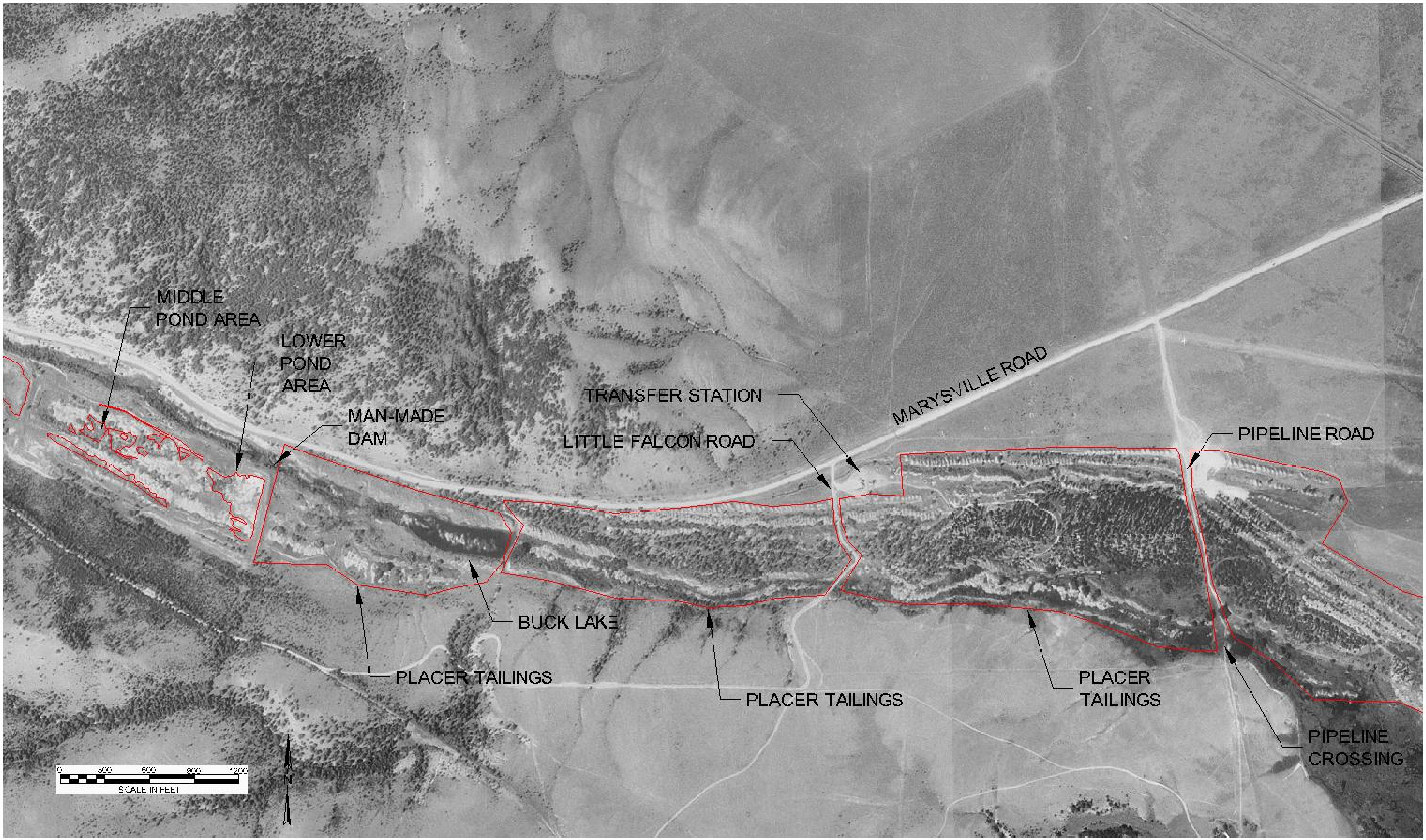
GOLDSIL AND UPPER, MIDDLE AND LOWER POND AREAS

FIGURE 1-6

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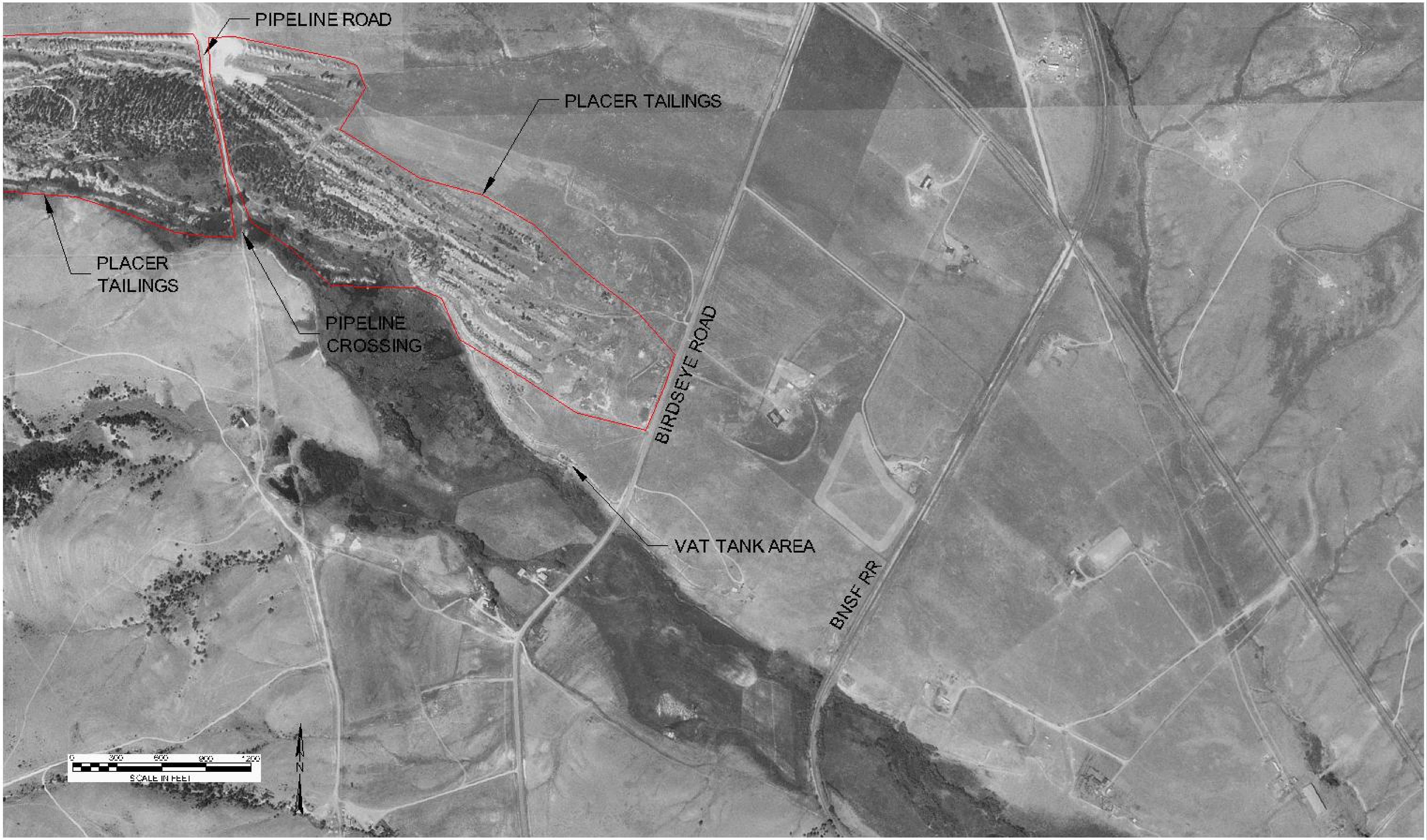


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MONTANA DEQ/MINE WASTE CLEANUP BUREAU
SILVER CREEK DRAINAGE CHARACTERIZATION
LEWIS & CLARK COUNTY, MONTANA

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SILVER CREEK BELOW BIRDSEYE ROAD

FIGURE 1-9


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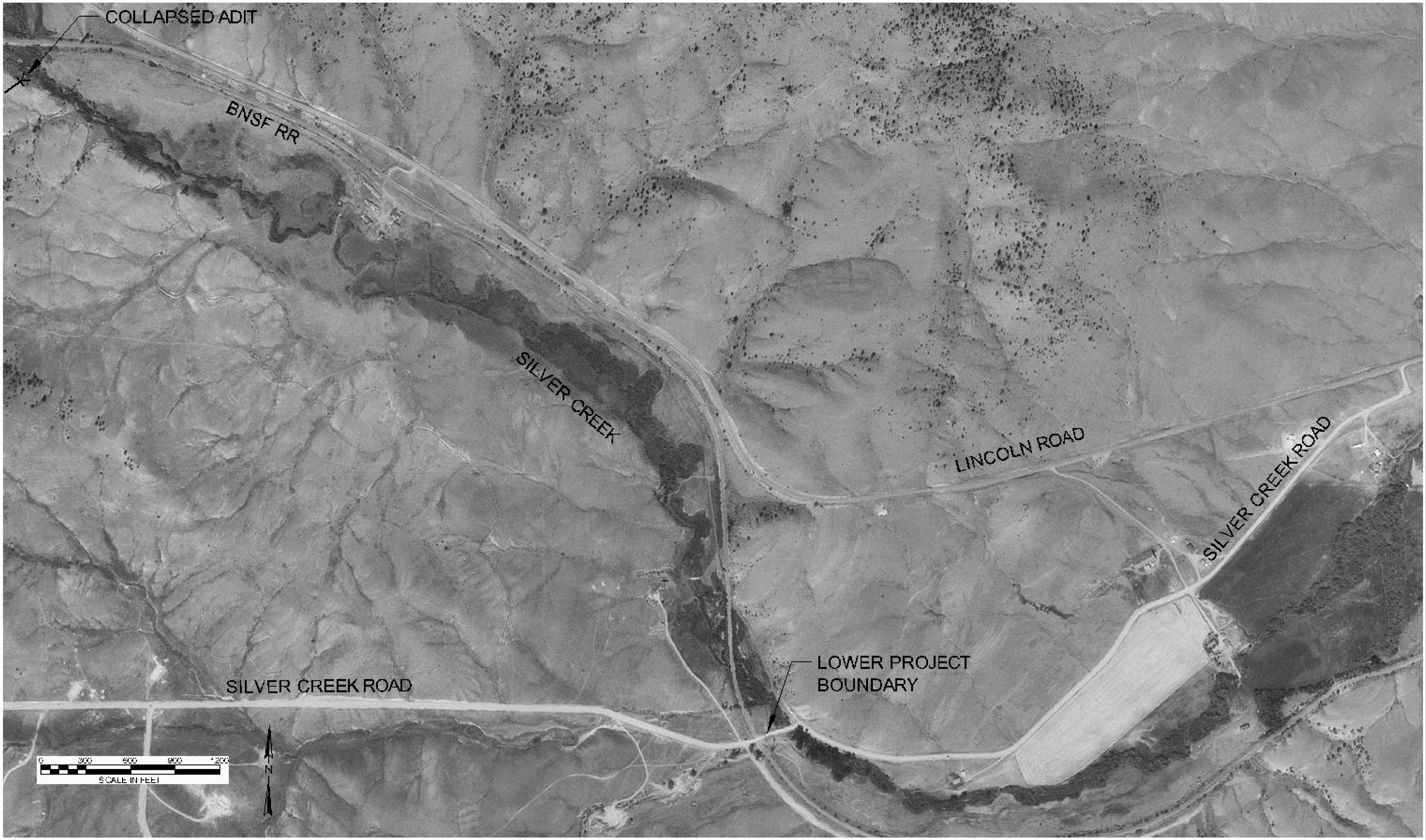


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LOWER SILVER CREEK AND SILVER CREEK ROAD

FIGURE 1-12

- Background Soil Quality;
- Mine/Mill Waste Characteristics;
- Sediment Characterization;
- Placer Tailings Characterization;
- Surface Water Characteristics (summarized from previous studies);
- Groundwater Characterization;
- Assessment of Airborne Particulate Emissions;
- Assessment of Physical Hazards;
- Summary of Contaminant Exposure Pathways, and
- Potential Repository Investigations.

## 1.1 REPORT ORGANIZATION

The Expanded Engineering Evaluation and Cost Analysis report is organized into 11 sections. The contents of each section are briefly described below and on the following pages:

**SECTION 2.0 BACKGROUND** - presents a background description of the Silver Creek Drainage Project's significant site features including: a detailed history of past mining and milling activities; geologic, hydrologic, and climatic characteristics of the site; the biological setting, such as the wildlife and fisheries resources and the vegetation indigenous to the area; threatened and endangered species concerns; and the cultural setting issues, such as present and future land uses, are described in this section.

**SECTION 3.0 WASTE CHARACTERISTICS AND SUMMARY OF THE SITE CHARACTERIZATION** - presents the results of the Phase I and II Site Characterization Reports which describes the characteristics of the wastes present at the site, including types, volumes, and contaminant concentrations. The impact to groundwater, surface water and stream sediments, an assessment of airborne particulate emissions and the results of the potential repository site investigations are also described in this section.

**SECTION 4.0 SUMMARY OF THE APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS** - presents the Montana Federal and State government requirements which are considered applicable or relevant and appropriate (ARAR) for the reclamation effort. Requirements discussed in this section are chemical-, location-, and action-specific ARARs.

**SECTION 5.0 SUMMARY OF RISK ASSESSMENT** - presents the risk analysis performed for the site. Potential sources, routes of exposure, and potential receptors are evaluated to determine the relative threats posed by each potential source within the project boundary. This evaluation is incorporated into a baseline Human Health Risk Assessment and an Ecological Risk Assessment.

**SECTION 6.0 PRELIMINARY RECLAMATION GOALS** - presents the reclamation objectives and applicable clean-up standards. Where appropriate, these objectives specify contaminants of concern (CoCs), media affected, exposure pathways, and preliminary reclamation goals (PRGs) for each environmental medium. PRGs are numerical values based on identified chemical-specific ARARs. PRGs are developed based on both ARARs and the results of the Risk Assessment activities.

**SECTION 7.0 DEVELOPMENT AND SCREENING OF RECLAMATION ALTERNATIVES** - identifies and screens potentially applicable reclamation alternatives. Reclamation alternatives are evaluated based on effectiveness, implementability, and cost.

**SECTION 8.0 DETAILED ANALYSIS OF RECLAMATION ALTERNATIVES** - presents a detailed analysis and comparison of the final screened alternatives against the National Contingency Plan (NCP) evaluation criteria. This includes a qualitative evaluation of threshold criteria, and how each alternative will mitigate risk from the contamination and comply with ARARs.

**SECTION 9.0 COMPARATIVE ANALYSIS OF RECLAMATION ALTERNATIVES** - compares the reclamation alternatives for consistency with ARAR requirements and develops the design approach for the final reclamation of the site.

**SECTION 10.0 PREFERRED ALTERNATIVE** - proposes a preferred reclamation alternative for the final reclamation activities at the site.

**SECTION 11.0 REFERENCES** - lists the references cited in the text.

# 2.0 BACKGROUND

Background information for the Silver Creek Drainage Project area is summarized in the following sections:

- Mining History
- Climate
- Geology, Hydrogeology, and Hydrology
- Current Site Setting

## 2.1 MINING HISTORY

The historic name of the Marysville mining district is the Ottawa mining district. The only town in the region, Marysville, is about 18 miles northwest of Helena. Silver Creek, which begins just above Marysville, runs eastward 16 air miles before discharging into Lake Helena. The gold-bearing gravels found in Silver Creek for four miles below the town were first discovered in 1862, but the richer bars were not worked until May of 1864. The pay streak was from 30 to 50 feet wide and gold was found on the bedrock 15 to 20 feet from the surface. The gold was valued at only $14 per ounce (as opposed to $17 gold from Last Chance Gulch) due to its high silver content. The stream was worked by hydraulicking, and the side bars in the gulch were said to have paid well. While no production figures are available for the early years and from 1870 to 1880, in 1869 the stream produced $50,000. Later in the 1880s, the district produced from $9,000 to $15,000 in placer gold. The stream has been estimated to have produced a total of $3,000,000 (Pardee and Schrader, 1933; Goodale, 1915; Axline, 1991).

Placer mining activities in the drainage occurred at various time periods. Approximately 75% of the activity was on Silver Creek, with the remaining activity on tributaries. Placer activity was reported to be sporadically active from the 1860s through 1921. Gold production through this time period is reported at $3.2 million (Lyden, 1987). Other periods of placer mining activity were in 1933 and from 1937 to 1941. During the period 1937 to 1941, a dragline dredge worked on bench and creek placers from the Silver City-Seven Mile Creek county road (Birdseye Road) upstream to within a short distance of the lowermost of several old tailings ponds, a distance of approximately 2 miles. Approximately 1,000,000 cubic yards of material were processed in this stream reach as a result of the dredging activity (Lyden, 1987). Although it is not known what separation processes were used in this operation, mercury was historically used as an amalgam to remove gold and silver from the black sand concentrates recovered by the dredges.

Hardrock mining in the drainage began about 1875 with the discovery of the lode gold deposits of the Drumlummon mine by Thomas Cruse. Major metal commodities were gold, silver, zinc, lead, and copper. The period of greatest prosperity for the area was from 1875 to 1921 (Lyden, 1987). The major hardrock mines in the Silver Creek drainage basin include the Drumlummon, Belmont, Bald Mountain, and Shannon mines. These mines, together with several other mines on the west side of the Continental Divide, likely produced over 30 million dollars of gold from 1875 through 1913 (Knoph, 1913). The mine workings in the headwaters area consist of numerous adits, small trenches and pits with associated waste rock dumps. Some of the workings are located high on the Continental Divide ridge line above the gulches on very steep terrain.

The lode mineral deposits in the Marysville Mining District are veins which have been categorized into the Drumlummon type and the Towsley Gulch type (McClernan, 1983). The Drumlummon type consists of platey calcite gangue and gold with minor sulfides, including tetrahedrite, chalcopyrite, pyrite, sphalerite, and galena. Manganese staining is prevalent in the ore, which occurs in shoots through the veins. The highest grade ore reportedly occurred near the surface in these veins, likely due to supergene enrichment. The Towsley Gulch type of veins are typified by more abundant sulfides with significant silver and lead values. These veins also contain abundant rounded fragments of country rock resembling a sedimentary conglomerate.

Mill production records for the various mine sites were reported by McClernan (1983). For the period of 1909 to 1948, total production for the combined Drumlummon, Belmont, and Bald Mountain mines was approximately 25,000 ounces of gold and 61,000 ounces of silver from 118,000 tons of ore. For the period of 1901 to 1948, production from the Drumlummon mill was approximately 116,000 ounces of gold and 853,000 ounces of silver from 480,000 tons of ore. Additional ore from the Drumlummon mine was likely processed at the Drumlummon Mill during the period from 1875 to 1900, although no records are available.

A mill was constructed in the mid 1970s east of Marysville by John White reportedly for the purpose of reprocessing mill tailings material. Operations at this mill were shut down in 1976 following reports of a fish kill in Silver Creek and an investigation by the Montana Department of Fish, Wildlife, and Parks (MDFWP). The mill was purchased in the late 1970s by Goldsil Ranchers Company and reportedly operated for a short time during the summer of 1980 until a fire and another reported seepage from the lower tailings pond caused mill operations to cease. The following timeline was constructed by Maxim Technologies, Inc. (DEQ-AMRB/Maxim,1996) from DEQ Water Quality Bureau files:

| | |
|---|---|
| Mid 1970s | White Mill Constructed |
| February 1976 | Fish kill reported below mill |
| October 1976 | High cyanide and metals concentrations measured in a mill pond, low cyanide and metals concentrations measured in Silver Creek by MDFWP during investigation of fish kills |
| September 1980 | >68 dead fish counted by WQB below mill |
| September 1981 | Consent Decree, District Court, Goldsil fined $5,000 and pays $4,755 agency costs |
| January 5, 1983 | Hydrometrics investigation of mercury and cyanide in Silver Creek completed |
| October 31, 1983 | Release of water to Silver Creek from new pond upstream of mill reported |
| February 31, 1984 | Goldsil submits mine permit application to Department of State Lands |
| July 7, 1984 | Goldsil submits response to comments to Department of State Lands |
| March 7-19, 1986 | Tailings pond at mill in danger of overflowing, pumped down |

July 9, 1986 Dead cows reported near mill, mill fenced off to cows

Currently the mill building is torn down and no mining or milling activities are known to be active in the drainage basin.

## 2.2 CLIMATE

There are no official weather stations in the Silver Creek drainage. There are two weather stations within generally an 8-mile radius around the Silver Creek drainage. National Oceanic and Atmospheric Administration's Western Regional Climate Center has compiled temperature and precipitation data at Canyon Creek (241450), Montana and Austin (240375), Montana for the periods May 6, 1907 through March 31, 1979 and April 12, 1950 through December 31, 2001, respectively. These appear to be the closest official weather stations to the Silver Creek drainage. Canyon Creek and Austin are approximately 4 miles northeast and 8 miles south of Marysville, respectively. The average annual maximum and minimum temperatures recorded at the Austin site were 53.6 degrees Fahrenheit (°F) and 29.6° F. Temperature data were not reported for the Canyon Creek site. The average annual total precipitation for the Canyon Creek and Austin sites is 10.82 and 16.15 inches, respectively. The lowest and highest average precipitation occurs in the months of February/March and May/June, respectively. Average annual total snowfall is 43.2 inches and 59.9 inches for Canyon Creek and Austin, respectively. Most snow falls from December through April.

Like most of southwestern Montana, the Silver Creek drainage is subject to a cool and dry continental-dominated climate. The temperature of the region is marked by wide seasonal and daily variations. During winter, the temperature can fall lower than 30 degrees below zero Fahrenheit (°F). During summer, many days reach the 80's and 90's but due to the generally arid climate and lightness of the mountain air, the temperature can drop substantially at nightfall. Precipitation in the basin averages 30 inches annually at Marysville (U.S. Soil Conservation Service, 1974). Approximately half of the annual precipitation falls as snow during winter (90 inches average annual snowfall). Stormy weather usually brings the first snow during September, however, these "equinoctial storms" are generally succeeded by several weeks of fair weather. By November, the area is usually blanketed with snow. Heavy snows are frequent in the winter as are periods of melting and freezing which occur as a result of warm Chinook winds that occasionally blow from the west. The snowpack generally remains in the area for six months or longer, with spring thaw occurring in April or May (NOAA, 1988).

The area is subject to a distinct spring/summer rainy season with May or June usually being the wettest month of the year. On average, May and June each receive 3.5 inches of precipitation. The frost-free period (32° F or more) averages approximately 70 days annually, from mid-June to late August (NOAA, 1988).

## 2.3 GEOLOGY, HYDROGEOLOGY, AND HYDROLOGY

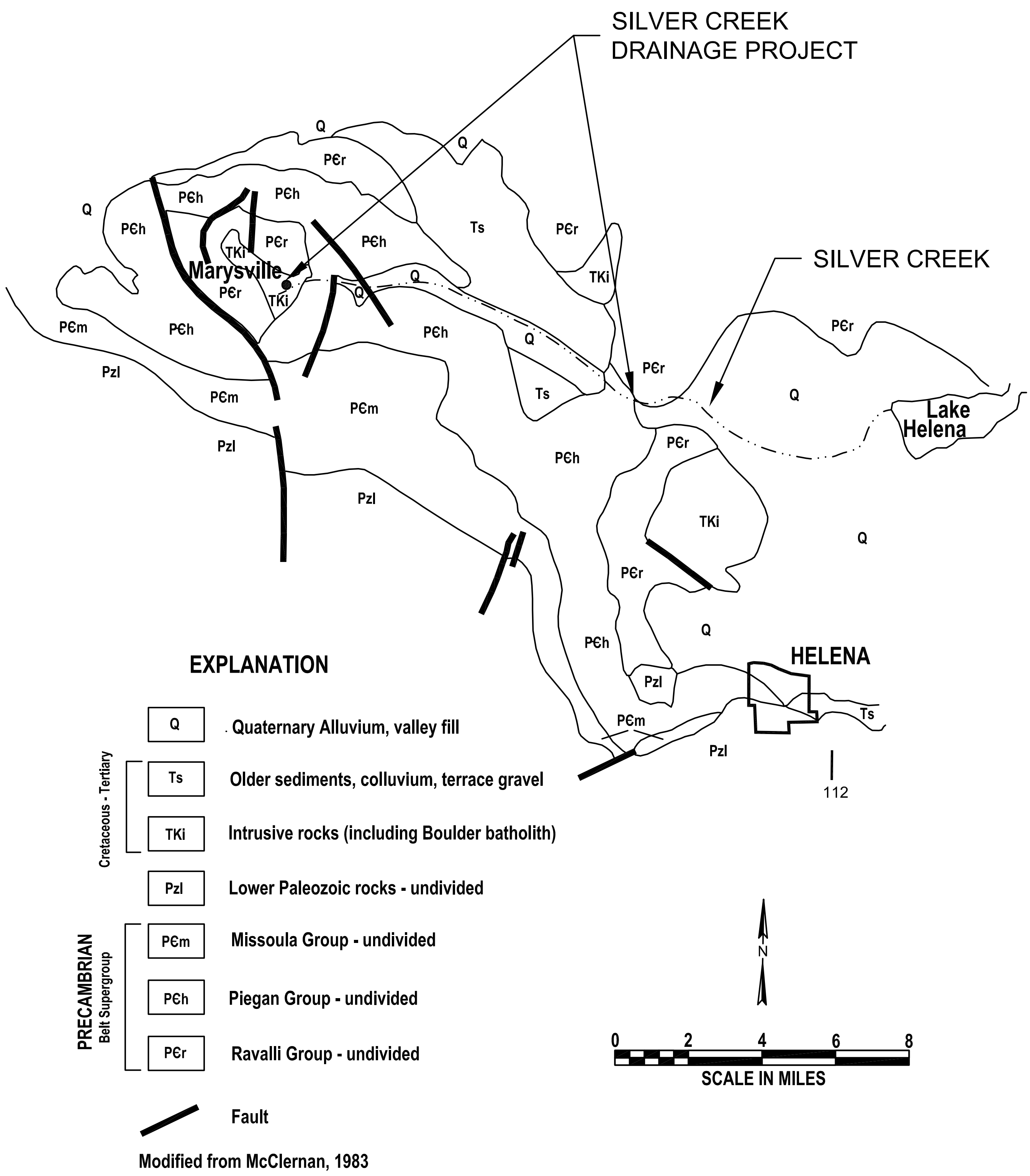
### 2.3.1 Local and Regional Geology

A significant portion of the Silver Creek Drainage Project is located within the general area of the Marysville mining district, located near the continental divide in Lewis & Clark County. The stratigraphy of the area comprises units of the Precambrian Belt Supergroup, hosting a contact metamorphic zone surrounding a series of Cretaceous and Tertiary intrusives. Structurally, the Marysville mining district is located near the eastern terminus of the Lewis and Clark line, a zone of east-west trending, right lateral strike-slip faults which appear to have been intermittently active since middle Proterozoic with an active stage between 82 and 45 million years ago (Ma) (Walker, 1992). The major evidence of this faulting in the Marysville area is a series of faults near Bald Butte. Additional structure in the area is represented by a slight doming of the metasedimentary units around the major intrusive body.

A generalized geologic map for the Silver Creek drainage area is presented in Figure 2-1. The stratigraphy of the major units in the area is summarized from Walker (1992). The two principal Precambrian units in the area are the Empire and Helena Formations (Knopf, 1913). The oldest formation exposed is the Empire Formation (Ravalli Group), characterized as a compact, locally calcareous, light to dark, greenish gray shale. Near Marysville, the shales have been metamorphosed to a fine-grained, light to dark green, gray or black hornfels banded green and purple. Overlying the Empire Formation hornfels is the Helena Formation (Piegan Group), generally a siliceous limestone, with some dolomite also present.

The oldest igneous rocks present are probably Precambrian microdiorite sills randomly distributed within the Empire and Helena Formations throughout the area. The sills are generally dark brown to black, less than three feet thick and often appear as swarms with multiple bands emplaced along bedding. The primary igneous unit, which forms the Marysville Stock, is a quartz diorite intruded at approximately 79 Ma. The surface exposure of the unit is irregular, with the main body located near the town of Marysville with an elongate extension to the Gloster mine area. A series of three porphyries of intermediate composition, and two hornblende diorite dikes, are also present within the western portion of the Marysville Mining district. At approximately 49 Ma, a rhyolite quartz porphyry intrusion occurred in the Bald Butte area, which was later intruded by a series of quartz porphyry sills and dikes between 37 to 40 Ma. The youngest igneous event in the mining district is a Tertiary rhyolite extrusive, dated at 37 Ma., occurring in limited exposures in the southwest portion of the Marysville mining district.

The Marysville mining district economic mineral deposits were contained in both placer and lode deposits. The gold and silver placer deposits are contained within unconsolidated alluvium in and around Silver Creek. Although gold and silver were the primary commodities in the lode deposits, lesser base metals including lead, zinc and copper were also produced. Gold occurred mostly as free gold, although there may have been some gold associated with pyrite at the Drumlummon and Gloster mines. Silver was associated with the gold and also occurred in other mineral phases including acanthite, tetrahedrite, and pearceite. The epigenetic and epithermal precious metal deposits occur in vein deposits hosted within the metasedimentary rocks near the contact zone with the quartz diorite of the Marysville stock. The veins are composed of varying amounts of quartz, carbonate and adularia gangue along with precious metals. The mining history indicates that sulfides typically increased with depth in the vein systems and sulfides included one or more of the following minerals: pyrite, chalcopyrite, galena and sphalerite. In areas known to have younger silicic intrustives at depth (i.e., Bald Butte and Empire Creek) veins are known to contain fluorite and molybdenite in addition to the normal epithermal mineral suite. Hydrothermal alteration differs on veins throughout the district. Alteration types include minor bleaching and kaolinization, silicification, and potassic alteration manifested by the intense development of biotite and orthoclase.




| | | |
|---|---|---|
| Olympus Technical Services, Inc. | GENERALIZED GEOLOGIC MAP<br>SILVER CREEK DRAINAGE PROJECT<br>Lewis & Clark County, Montana | FIGURE<br>2-1 |

### 2.3.2 Hydrogeology

Hydrogeologic information specific to the Silver Creek area include a permit application for Goldsil Mining and Milling, Inc. prepared by Hydrometrics and submitted to the Montana Department of State Lands in 1984 (Goldsil Mining and Milling, 1984a). The following general observations on the hydrogeologic setting are based on information in this application as well as accepted hydrologic and geologic principles and local observations.

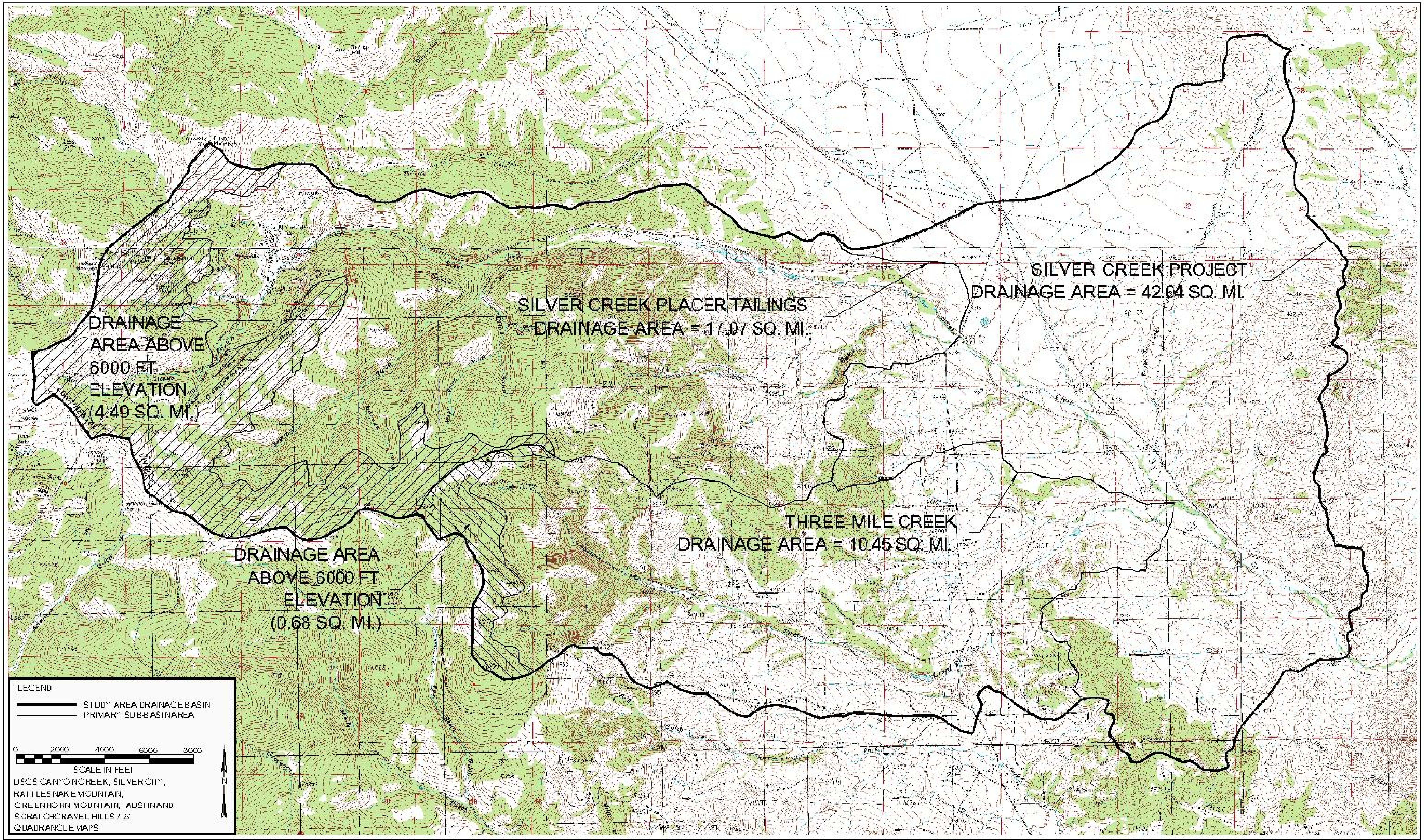
The Silver Creek drainage basin is comprised of a headwaters area near the town of Marysville and several major tributaries flowing from the south. The hydrogeologic system contains two main components; bedrock and alluvial valley fill. The bedrock is moderately fractured and contains vein structures associated with the intrusion of the stock. Numerous fractures are present in the bedrock, including bedding structures, joints and faults associated with the tectonic history, and vein structures. The dolomite of the Helena Formation could also contain secondary groundwater flow pathways due to solution of the dolomite by groundwater. Due to the complex and unpredictable nature of the bedrock structures, it is likely that the rate and direction of groundwater flow is widely variable over short distances. Permeability and transmissivity of the bedrock aquifer system probably vary widely. The alluvial deposits are thin, shallow, and discontinuous and likely transmit both surface water from local streams and discharging bedrock groundwater.

Groundwater flow likely follows local stream gradients and topography, with groundwater discharging to gaining alluvial streams which is typical of high mountain drainage systems. However, local bedrock fault systems and secondary solution features probably exert significant control on the direction and rate of groundwater flow, as do the underground workings associated with the mines in the area.

### 2.3.3 Surface Water Hydrology

Surface hydrology in the Silver Creek drainage basin consists of Silver Creek and several perennial and intermittent gulches. Figure 2-2 shows the drainage area of the Silver Creek Drainage Project. In the upper reaches, Silver Creek is formed by the confluence of surface water flow from Ottawa and Rawhide gulches above the town of Marysville. Jennies Fork, which drains the area northwest of Marysville, enters Silver Creek from the north immediately downstream of Marysville. Other major tributaries to Silver Creek downstream from Marysville include Sawmill Gulch, Sitzer Gulch, and Threemile Creek, all entering from the south (Figure 2-2). No significant mining activity is known to have been performed in any of these three tributary drainages.

Contributions to surface water flow in the headwaters of Silver Creek also include the discharges from several abandoned mines. Adit discharges have been documented from the Shannon Mine, Bald Mountain Mine, Belmont Mine, and the Drumlummon Mine (DEQ-AMRB/Maxim, 1996). Discharges from abandoned adits associated with the Bald Mountain and Belmont mine were sampled during the spring of 1996 prior to reclamation work on these discharges (DEQ-AMRB/Maxim, 1996).




| NO | REVISION DESCRIPTION | BY | DATE | DESIGN: | DRAWN: KSR | CHECKED: CRS |
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| | | | | SCALE: AS SHOWN | FILENAME: A1231FSP.dwg | |

MONTANA DEQ/MINE WASTE CLEANUP BUREAU
SILVER CREEK DRAINAGE PROJECT
LEWIS & CLARK COUNTY, MONTANA

**Olympus Technical Services, Inc.**

SILVER CREEK
DRAINAGE AREA MAP

FIGURE
2-2

The hydrology of the headwaters area of Silver Creek above Marysville has been slightly affected by mine adits and by mine waste rock piles. Severe effects to the stream hydrology by placer mining and deposition of mill wastes are present from Marysville to the Birdseye road. The majority of the valley bottom and flood plain in this lower reach has been placer mined and several mill tailings ponds are located in the floodplain. A tailings dam associated with the Drumlummon Mill is located in the Silver Creek approximately 1.5 miles downstream from Marysville. This tailings dam failed during high flows which occurred in the spring of 1992 and was repaired by the land owner in 1994 by placing riprap along two channels which convey Silver Creek through the breached dam. Several other tailings dams and ponds have been constructed in old placer tailings material downstream of the breached tailings dam. These ponds are located in dredge tailings on the south bank of Silver Creek and were associated with a mill constructed by John White in the 1970s. This mill was also operated by the Goldsil Mining Company during the 1980s.

There are no records for stream gaging stations on Silver Creek. A gaging station was operated on Little Prickly Pear Creek near Marysville from 1913 through 1932. Little Prickly Pear Creek is the drainage directly north of Marysville. The gaging station has a reported drainage area of 44.40 square miles and a gage datum of 4,700 feet above sea level. Omang (1992) reports flood frequency data at the Little Prickly Pear gaging station based on the data for the period of record as shown in Table 2-1.

**TABLE 2-1 PEAK DISCHARGE FOR LITTLE PRICKLY PEAR CREEK NEAR MARYSVILLE (OMANG, 1992)**

| Recurrence Interval (years) | Peak Discharge in cubic feet/second (cfs) |
|---|---|
| 2 | 141 |
| 5 | 255 |
| 10 | 354 |
| 25 | 510 |
| 50 | 650 |
| 100 | 813 |

A procedure developed by Omang (1992) that uses the drainage-area ratio of an ungaged site to that of a gaged site was used to estimate the magnitude and frequency of floods for the Silver Creek drainage for the project area. This method is valid for drainage areas that are between 0.5 and 1.5 times the area of the gaged drainage area. The Silver Creek Drainage Project covers an area of 42.04 square miles, which is 94.7 percent of the gaged drainage area. The peak discharges for the Silver Creek drainage estimated by drainage-area ratios are shown in Table 2-2.

Peak discharge for Silver Creek was also estimated using regional flood-frequency equations developed by Omang (1992). The regional equations for southwest Montana use the drainage basin area (42.04 square miles) and the percentage of the basin area above 6,000 feet in elevation (12.3 percent) to estimate peak discharge. Peak discharges estimated by regional flood-frequency equations for the Silver Creek drainage are shown in Table 2-2.

The known waste sources are all located upstream of Birdseye Road. The peak discharges for this upper portion of the Silver Creek basin were estimated using the regional flood-frequency equations. Peak discharges for the Silver Creek drainage upstream of Birdseye Road were estimated by regional flood-frequency equations (drainage area of 17.07 square miles and 26.3 percent of the basin above 6,000 feet in elevation) and are presented in Table 2-3.

**TABLE 2-2 ESTIMATES OF PEAK DISCHARGE FOR THE SILVER CREEK DRAINAGE PROJECT AREA**

| Recurrence Interval (years) | Peak Discharge (cfs) by Drainage-Area Ratio | Peak Discharge (cfs) by Regional Flood-Frequency Equations |
|---|---|---|
| 2 | 135 | 116 |
| 5 | 244 | 324 |
| 10 | 339 | 557 |
| 25 | 490 | 958 |
| 50 | 626 | 1389 |
| 100 | 783 | 1942 |

**TABLE 2-3 ESTIMATES OF PEAK DISCHARGE FOR THE SILVER CREEK DRAINAGE ABOVE BIRDSEYE ROAD**

| Recurrence Interval (years) | Peak Discharge (cfs) by Regional Flood-Frequency Equations |
|---|---|
| 2 | 58 |
| 5 | 143 |
| 10 | 236 |
| 25 | 394 |
| 50 | 546 |
| 100 | 734 |

## 2.4 CURRENT SITE SETTING

### 2.4.1 Location and Topography

The Silver Creek drainage basin is located in Townships 11 and 12 North, Ranges 4, 5 and 6 West, in Lewis and Clark County on public and private land. The latitude of the basin is between North 46° 40' and 46° 50' and the longitude is between West 112° 00' and West 112° 21'. Silver Creek is formed by the confluence of streams flowing from Rawhide and Ottawa Gulches near the town of Marysville. From Marysville, Silver Creek flows eastward for approximately 16 air miles, crossing the northern portion of the Helena Valley before it enters Lake Helena. Due to irrigation diversions and other withdrawals, Silver Creek is intermittent in its lower reaches and does not reach the lake. Lake Helena is connected to Hauser Lake on the Missouri River.

The highest point in the Silver Creek drainage basin is Mount Belmont at an elevation of 7,331 feet above sea level. The topography of the basin is mountainous and is mostly forested. The terrain surrounding the mines in the headwaters of the drainage basin is generally rugged, consisting of relatively steep slopes (15 to 20 degrees). The land is used for wildlife habitat, livestock grazing, and recreation. The western boundary of the drainage basin is formed by the Continental Divide.

### 2.4.2 Vegetation/Wildlife

The area in the upper portions of the Silver Creek drainage above the town of Marysville is mostly continuously timbered with Lodgepole pine, Douglas fir, Engelmann spruce, and some Ponderosa pine. The area is important habitat for a variety of big game animals (mule deer, elk, moose, black bear), fur bearers (beaver and bobcat), waterfowl and birds. The area in the lower portions of the drainage is characterized by juniper, sagebrush, and native grasses.

Recreation in the drainage includes hunting and fishing. Silver Creek was reported as a good quality fishery with numerous trout being counted in the upper portion of the creek during a fish survey (Montana Department of Fish and Game, 1977). The lower section of the creek had been reported as a good quality fishery, however no trout were found in the lower section during the fish survey possibly due to a fish kill.

The MDFWP fisheries information contained in the Montana Rivers Information System (MRIS) database (MRIS, 2002) indicates that Silver Creek is 21.6 miles long and has a Fisheries Resource Value (FRV) of 4 for both habitat class and sport class, with a final value of moderate.

According to the MRIS database, Brook Trout are year-round residents and are considered present in abundance. Westslope Cutthroat Trout are year-round residents and are considered common in abundance. Brown Trout, Kokanee and Rainbow Trout are residents and use this stream reach for spawning, but are uncommon in abundance. Silver Creek is posted by MDFWP as catch and release only because of elevated mercury concentrations in fish tissue, however, this is not reported in the MRIS database.

### 2.4.3 Historic or Archaeologically Significant Features

***(To be completed upon receipt of the Cultural Resources Inventory from DEQ)***

### 2.4.4 Land Use and Population

The small community of Marysville is located on Silver Creek near its headwaters. An estimated 50 residents live year-round at Marysville, and approximately 10 additional cabins are located in the vicinity of the townsite for recreational/seasonal use. Recreational land use near Marysville includes hunting, fishing, camping, hiking, 4-wheeling, mountain biking, snowmobiling, and skiing. The Great Divide Ski Area is located at the base of Mt. Belmont and experiences approximately 30,000 to 40,000 skier days per year (Maxim, 1995).

# 3.0 WASTE CHARACTERISTICS AND SUMMARY OF RECLAMATION INVESTIGATION

The objective of the Silver Creek Drainage Project Phase I and Phase II site characterizations was to evaluate the abandoned mine/mill wastes at the site while generating a database which met the requirements necessary to complete a risk assessment and detailed analysis of reclamation alternatives. The Phase I and Phase II Site Characterization Reports (DEQ-MWCB/Olympus, 2003a and 2003b) present the results of the reclamation investigation activities. The data generated to support the two primary tasks are summarized as follows:

Risk Assessment Data Requirements:

- Establish background soil concentrations with at least 6 background samples;
- Characterize vertical and lateral metal concentration variations in waste sources and assess the 0 to 6 inches zone for direct contact and air emission potential;
- Evaluate the physical and chemical properties of the source material that may affect contaminant migration including: pH, metal concentrations, leaching potential, acid/base accounting and particle size distribution;
- Inventory solid and hazardous waste materials on site associated with past mining;;
- Characterize impacts to shallow groundwater by conducting a limited groundwater assessment;
- Assess physical hazards associated with potential open adits or shafts, pits, trenches, highwalls and dilapidated structures, etc.; and
- Assess surface water and groundwater uses and estimate other ecological uses.

Feasibility Study Data Requirements Include:

- Determine accurate areas and volumes of the contaminant source materials including mill tailings, waste rock piles, and estimated areas and volumes of placer tailings;
- Contaminant concentration variations and leaching characteristics of the waste sources;
- Representative acid/base accounting characteristics of the mill tailings and waste rock;
- Determine depth and gradient of shallow groundwater in potential repository area;
- Determine hydrologic configuration of the Silver Creek channel in the vicinity of the tailings piles;
- Determine physical characteristics and dimensions of open accesses to open pit and underground mine workings;
- Identification of potential borrow source areas for cover soil;

- Assess revegetation parameters for cover soil sources including soil texture and grain size, nitrogen, phosphorus, potassium, percent organic matter, pH and conductivity; and

- Determine optional locations and soil characteristics for repository site(s).

The principal techniques used for data acquisition in this site investigation were backhoe test pits, shovel/hand auger test holes, and geoprobe drill holes, field mapping, soil, sediment and groundwater sampling. Samples were collected using standard operating procedures that are contained in the Field Sampling Plans (DEQ-MWCB/Olympus, 2002a and 2002b) and were analyzed according to the Laboratory Analytical Protocol (DEQ-MWCB/Olympus, 2002d). Analytical data were evaluated for quality assurance according to the Quality Assurance Project Plan (DEQ-MWCB/Olympus, 2002e). The site characterization work was completed according to a health and safety plan (DEQ-MWCB/Olympus, 2002c).

The site characterization field program included collecting solids samples for the following types of analyses:

- Multi-element X-Ray Fluorescence (XRF) screening. XRF analyses were generally completed for all solid sampling intervals. The XRF analyses determined qualitative to semi-quantitative concentrations of the following elements: Ag, As, Ba, Ca, Cd, Co, CrVI, CrIII, Cu, Fe, Hg, K, Mn, Mo, Ni, Pb, Rb, Sb, Se, Sn, Sr, Ti, Th, U, Zn, and Zr.

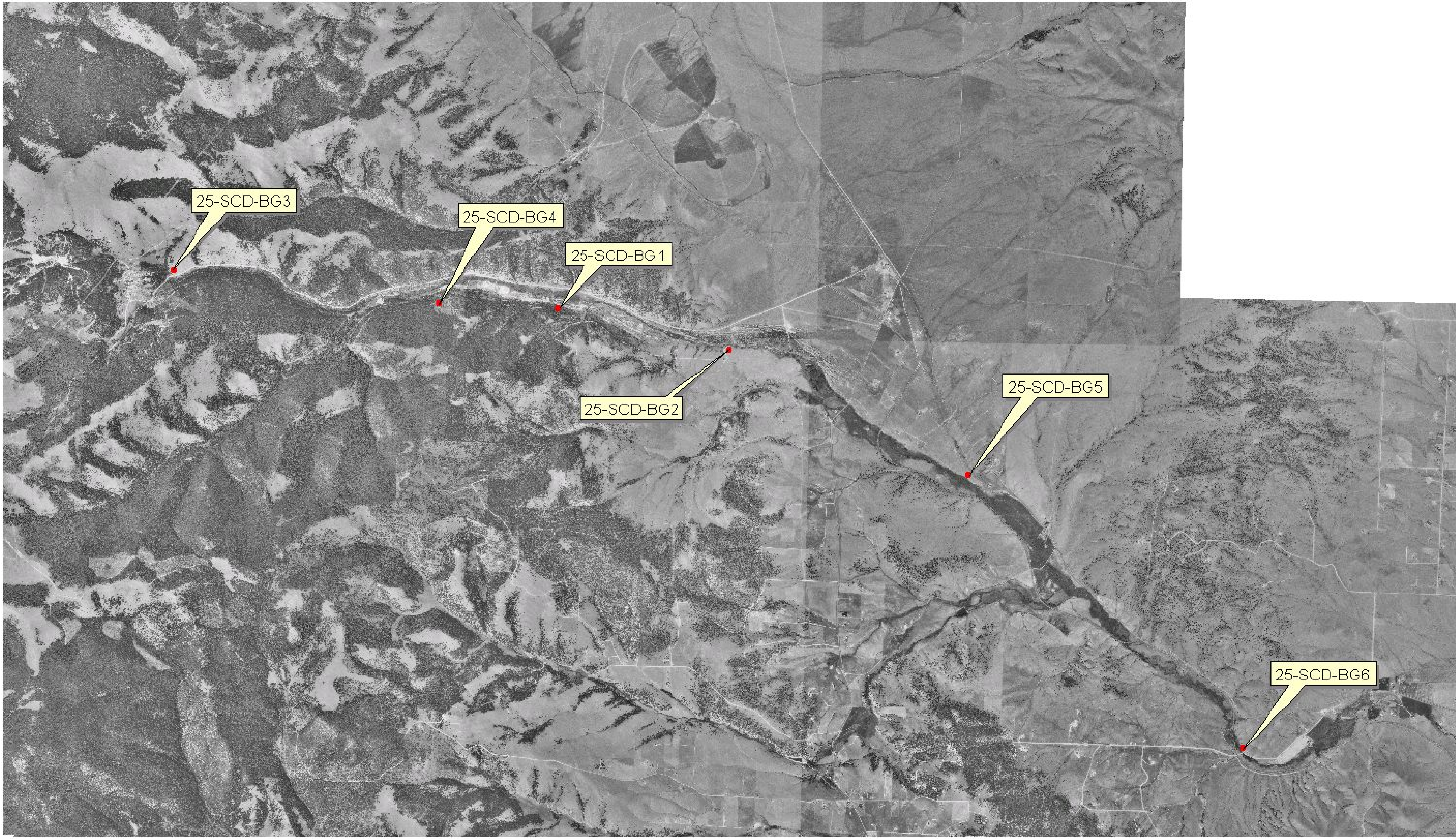
- Target analyte list (TAL) for commercial laboratory. This includes total metals and non-metals analyses following the EPA Contract Lab Program (CLP) Methods for determining the concentrations of the following elements: As, Cd, Cu, Pb, Hg, and Zn (Phase I) and Ag, As, Ba, Cd, Cr, Cu, Fe, Hg, Mn, Ni, Pb, Sb, Zn (Phase II). Both sample suites were also analyzed for total cyanide and paste pH. Laboratory analyses for the TAL were all performed at Energy Laboratories in Billings, Montana.

- Acid/Base Accounting (ABA) analyses including determination of sulfur fractions and neutralization potential. These analyses were all performed at Energy Laboratories in Billings, Montana.

- Hazardous waste characteristics, determined by analysis for Toxicity Characteristic Leaching Procedure (TCLP) metals analysis for the following elements: Ag, As, Ba, Cd, Cr, Hg, Pb, and Se. These analyses were performed at Energy Laboratories in Billings, Montana.

## 3.1 BACKGROUND SOIL SAMPLES

Six background soil samples were collected from the Silver Creek Drainage Project area. Four samples were collected during Phase I and two samples were collected during Phase II site characterization. The sample locations are shown on Figure 3-1. The samples were selected to provide representative coverage of the Silver Creek Drainage Project Area outside of known waste areas and other areas of disturbance. Sample locations were selected to be representative of soils derived from the country rock present in the area of the drainage basin.




Olympus Technical Services, Inc.

0 4000 8000 Feet

N

Legend

Background Soil Sample

Figure 3-1
Background Soil Sample Locations

Background soil samples were screened for a multi-element suite using a portable X-ray fluorescence (XRF) analyzer and the same samples were analyzed at Energy Laboratories for pH and the following total metals: As, Cd, Cu, Hg, Pb and Zn (Phase I) and Ag, As, Ba, Cd, Cr, Cu, Fe, Hg, Mn, Ni, Pb, Sb and Zn (Phase II). The background soil qualitative to semi-quantitative XRF range and mean concentration results for the principal elements of interest are as follows: Ag (no detection), As (14-31 ppm and 23.8 ppm), Ba (697-1,154 ppm and 880.5 ppm), Cd (no detection), Cr (no detection), Cu (no detection), Fe (10,480-20,760 ppm and 15,808.3 ppm), Hg (no detection), Mn (430-750 ppm and 533.3 ppm), Ni (180-537 ppm and 376.5 ppm), Pb (no detection), Sb (56-104 ppm and 85.2 ppm), and Zn (28-75 ppm and 46.4 ppm). The laboratory results for the background samples are presented in Table 3-1, with the mean concentrations summarized as follows:

**Mean Background Soil Element Concentrations** (quantitative laboratory results)
**All Results in mg/kg**

| pH | Ag | As | Ba | Cd | Cr | Cu | Fe | Hg | Mn | Ni | Pb | Sb | Zn |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7.37 | ND | 21.4 | 145 | ND | 12 | 34.2 | 13,700 | ND | 504 | 9 | 11.3 | 4.8 | 68.8 |

ND No detection

## 3.2 MINE/MILL WASTE SOURCES

The Phase I and Phase II site characterization reports evaluated approximately 10.1 miles of Silver Creek and Jennies Fork channel and immediate floodplain and known waste sources outside of the immediate Silver Creek channel and floodplain. An additional 2.0 miles of Silver Creek channel in the project area were not evaluated because landowner access agreements were not executed. This work evaluated a number of waste sources including eight mill tailings, four waste rock and numerous placer tailings. Figure 1-1 is a map focusing on the overall Silver Creek Drainage Project area and illustrates the major features, including the Silver Creek drainage and the associated tailings, waste rock, and placer tailings piles that were investigated. The general information regarding each waste source, including area (if applicable), location, average thickness (if applicable), volume, number of test locations, number of XRF samples and number of composite laboratory samples is listed in Table 3-2. The following sections summarize the results of the site characterization report for each of the waste sources.

### 3.2.1 Tailings Pile Waste Characteristics

The majority of the mill tailings occur in seven areas in the Silver Creek drainage. These tailings areas in order from the largest to smallest volume are identified as follows: Goldsil tailings, Drumlummon tailings, Goldsil millsite tailings, Upper Pond Area, Lower Pond Area, Middle Pond Area, and Drumlummon millsite tailings. Tailings piles are generally created by depositing sediment slurry into a basin setting. Thus tailings piles commonly exhibit a stratigraphy that is similar to undisturbed sedimentary rocks with vertical layering and lateral facies changes. Chemical changes in the pile are directly related to changes in the chemistry of the orebody and/or changes in the metallurgical processing method. Some of the tailings piles in the Silver Creek Drainage Project are further complicated by the fact that they have been disturbed and reprocessed after initial deposition. The tailings volume, geology and chemistry for each of these tailings areas is summarized below.

**Table 3-1. Background Soil Laboratory Results**

| Sample ID | Paste pH | Ag (mg/Kg) | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 25-SCD-BG1 | 7.1 | | 46 | | <1 | | 18 | | <1 | | | 15 | | 70 |
| 25-SCD-BG2 | 7.6 | | 46 | | <1 | | 19 | | <1 | | | 9 | | 28 |
| 25-SCD-BG3 | 7.3 | <5 | <5 | 164 | <1 | 15 | 20 | 14000 | <1 | 568 | 9 | 7 | <5 | 57 |
| 25-SCD-BG4 | 7.3 | <5 | 22 | 126 | <1 | 9 | 16 | 13400 | <1 | 440 | 9 | 13 | 7 | 56 |
| 25-SCD-BG5 | 7.6 | | 6 | | <1 | | 27 | | <1 | | | 9 | | 112 |
| 25-SCD-BG6 | 7.3 | | 6 | | <1 | | 105 | | <1 | | | 15 | | 90 |
| **Maximum** | 7.6 | <5 | 46 | 164 | <1 | 15 | 105 | 14000 | <1 | 568 | 9 | 15 | 7 | 112 |
| **Minimum** | 7.1 | <5 | 6 | 126 | <1 | 9 | 16 | 13400 | <1 | 440 | 9 | 7 | <5 | 28 |
| **Mean** | 7.37 | | 21.4 | 145.0 | | 12.0 | 34.2 | 13700.0 | | 504.0 | 9.0 | 11.3 | 4.8 | 68.8 |
| **n** | 6 | 2 | 6 | 2 | 6 | 2 | 6 | 2 | 6 | 2 | 2 | 6 | 2 | 6 |

Pioneer Background Samples

| Sample ID | Ag (mg/Kg) | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Big Ox Mine | | 25 | 650 | <0.4 | 10.7 | 32.6 | 14700 | 0.187 | 662 | 14 | 28 | <3 | 75 |
| Drumlummon | <0.7 | 8.2 | 312 | <0.6 | 15 | 12.1 | 14500 | <0.03 | 454 | 9.8 | <8.56 | <6.9 | 58.1 |
| Empire Mine | | 38 | 239 | <0.5 | 14.1 | 49.7 | 19500 | 0.122 | 1000 | <15 | 80 | <4 | 153 |
| Mean | | 23.73 | 400.3 | | 13.27 | 31.47 | 16233.33 | 0.1545 | 705.3 | 11.90 | 54.0 | | 95.37 |
| Maximim | | 38 | 650 | | 15 | 49.7 | 19500 | 0.187 | 1000 | 14 | 80 | | 153 |

**LEGEND**

25-SCD-BG1 Sample site on south hillside between Goldsil Millsite and Upper Pond
25-SCD-BG2 Sample site on south hillside east of Little Falcon Road
25-SCD-BG3 Sample site north of Silver Creek on ridge east of Jennies Fork
25-SCD-BG4 Sample site west of Argo millsite on hillside just above old railbed
25-SCD-BG5 Sample site on plateau on northside of Silver Creek near Silver Fox Court
25-SCD-BG6 Sample site on ridge east of Silver Creek and north of Silver Creek Road

Note: Statistics - one half the lower detection limit is used where below detection limit samples are included in the mean calculation

**Table 3-2. Summary of General Information for Silver Creek Drainage Project Waste Sources**

| Waste Source Identification | Area (Acres) | Location (Section, Township, Range) | Average Thickness Estimated (feet) | Waste Volume (cubic yards) | Test Locations[1] | XRF Samples | Laboratory Composite Samples |
|---|---|---|---|---|---|---|---|
| Goldsil tailings area | | SE¼ Sec 33, T12N, R5W; SW¼ Sec 34, T12N, R5W | | | | | |
| Main Tailings | 18.68 | | 15.2 | 458,430 | 30 | 108 | 15 |
| Lined Pond Area Tailings | 1.97 | | 1.1 | 3,440 | 8 | | |
| Lined Pond Berm Tailings | 1.87 | | 2.5 | 7,550 | 2 | | |
| Drumlummon tailings | 5.45 | SE¼ Sec 32, T12N, R5W | 6.8 | 59,780 | 21 | 31 | 4 |
| Goldsil Millsite area tailings | | SW¼ Sec 34, T12N, R5W | | | | | |
| Block 1 - Lined Ditch | 0.41 | | 1.0 | 660 | 10 | | |
| Block 2 - Lobe North of Ditch | 0.12 | | 3.8 | 740 | 5 | | |
| Block 3 - Mill Vat Tank Area | 0.43 | | 1.7 | 1,200 | 8 | 15 | 3 |
| Block 4 - Mill Ramp Area | 1.07 | | 11.6 | 19,870 | 18 | 10 | 3 |
| Block 5 - Mill Tanks | 0.05 | | <1.5 | 80 | 4 | 1 | |
| Upper Pond Area tailings | 2.23 | SE¼ Sec 34, T12N, R5W | 6.0 | 20,720 | 9 | 25 | 3 |
| Lower Pond Area tailings | 1.77 | NE¼ Sec 3, T11N, R5W | 6.2 | 17,670 | 11 | 21 | 2 |
| Middle Pond Area tailings | 1.97 | SE¼ Sec 34, T12N, R5W; NE¼ Sec 3, T11N, R5W | <5.0 | 11,280 | 31 | 22 | 5 |
| Drumlummon Millsite tailings | | SE¼ Sec 36, T12N, R6W | | | | | |
| Mill Foundation | | | | <50 | | 1 | 1 |
| TP-1 | 1.22 | | 2.3 | 4,530 | 5 | 2 | 2 |
| TP-2 | 0.54 | | 1.8 | 1,540 | 6 | 1 | 1 |
| TP-3 | 1.04 | | 2.7 | 4,450 | 3 | 1 | 1 |
| Waste Rock Pile WR1 | 0.19 | SE¼ Sec 36, T12N, R6W | 4.7 | 1,460 | 5 | 1 | 1 |
| Waste Rock Pile WR2 | 0.34 | SE¼ Sec 36, T12N, R6W | 5.4 | 2,960 | 10 | 2 | 1 |
| Waste Rock Pile WR3 | 0.45 | SE¼ Sec 36, T12N, R6W | 4.8 | 3,500 | 15 | 3 | 1 |
| Waste Rock Pile WR4 | 2.77 | SE¼ Sec 36, T12N, R6W | 24.8 | 110,510 | 15 | 3 | 1 |

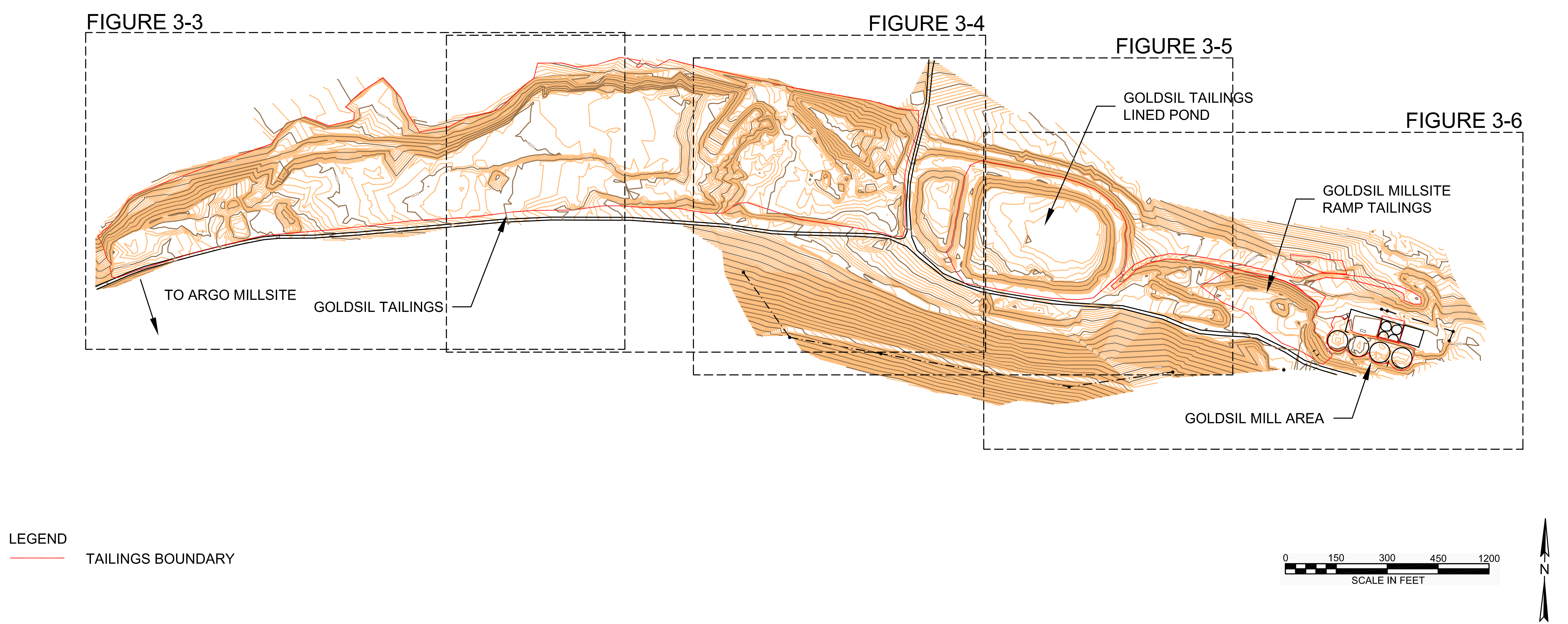
[1]Test locations may include one or more of the following methods: backhoe test pit, geoprobe drill hole, shovel test pit or hand auger boring

#### 3.2.1.1 Goldsil Tailings Volume, Geology and Chemistry

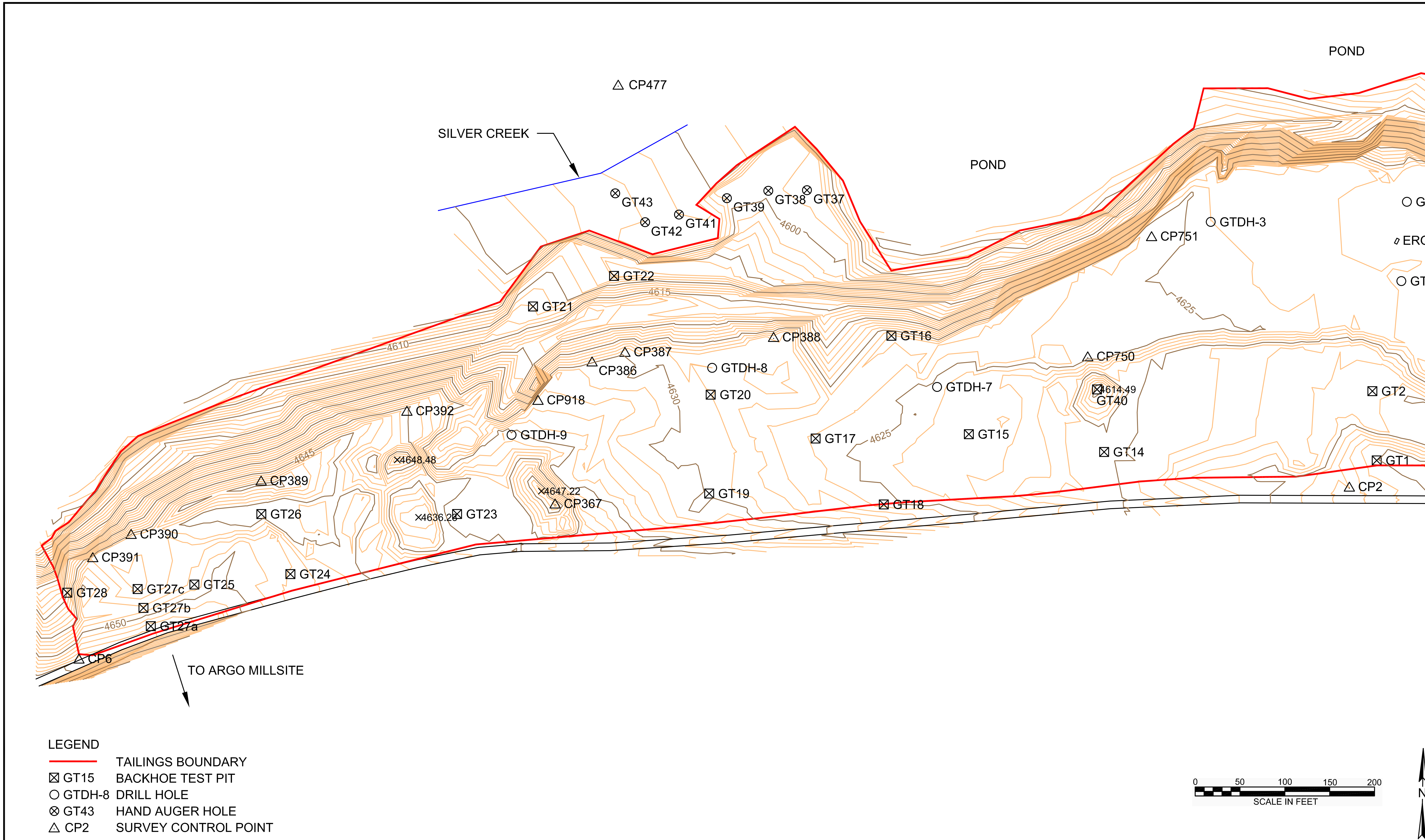
The Goldsil tailings piles are located in the SE¼ Section 33 and SW¼ Section 34, Township 12 North and Range 5 West, Montana Principal Meridian (Figure 1-1). The area encompassing the Goldsil mill tailings extends from just north of the Argo millsite to the Goldsil millsite, a distance of approximately 4,000 feet. An overview of the Goldsil millsite and tailings area is presented in Figure 3-2. Additional larger scale maps showing the details of the Goldsil tailings area are presented in Figures 3-3, 3-4, 3-5, and 3-6. The Goldsil tailings volume was estimated using the detailed topographic survey of the tailings surface and the drill hole and test pit data. The volume estimate methods are detailed in the Silver Creek Drainage Project Phase II Site Characterization Report (DEQ-MWCB/Olympus, 2003b). A total volume estimate for the mill tailings contained in the Goldsil tailings area of the Silver Creek Drainage Project is 491,970 cubic yards (cy). Because of the size and complexity of the Goldsil tailings area, it was divided into subareas with volume estimates as follows:

- the main Goldsil tailings occupies 18.68 acres, is located west of the upper Goldsil access road and contains 458,430 cy;
- tailings within the lined pond east of the Goldsil tailings occupy 1.97 acres and contain 3,440 cy;
- the lined pond berm which appears to be a mixture of tailings and native soil occupies 1.87 acres and is estimated to contain 7,550 cy;
- the lined ditch from the lined pond that flows to a former pond north of the Goldsil mill area occupies 0.41 acres and contains an estimated 660 cy of tailings;
- a lobe of tailings located north of the lined ditch occupies 0.12 acres and contains 740 cy of tailings;
- the Goldsil mill vat tank area occupies 0.43 acres and is estimated to contain 1,200 cy of tailings;
- the ramp west of the Goldsil mill occupies 1.07 acres and contains 19,870 cy of tailings; and
- the tanks within the Goldsil mill foundation occupy 0.05 acres and contain an estimated 80 cy of tailings.

The Goldsil tailings are complex because some zones have been disturbed due to 1) secondary mining and reprocessing and, 2) sediment erosion caused by stormwater and snowmelt runoff. An open pit mine was presumably constructed in the 1970's near the central portion of the Goldsil tailings area (Figure 3-4) to extract and reprocess tailings for gold and silver. Based on the size of the open pit mine area and various interpretations of the pre-mining topographic surface, it is estimated that from 108,000 to 178,000 cubic yards of tailings were removed from the pile during this operation. It is not known whether all or only a portion of the extracted tailings were reprocessed at the Goldsil millsite.




| NO. | REVISION DESCRIPTION | BY | DATE | DESIGN: | DRAWN: KSR | CHECKED: CRS | MONTANA DEQ/MINE WASTE CLEANUP BUREAU<br>SILVER CREEK DRAINAGE PROJECT<br>LEWIS & CLARK COUNTY, MONTANA | Olympus Technical Services, Inc. | GOLDSIL MILLSITE<br>AND TAILINGS AREA | FIGURE<br>3-2 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | APPROVED: | DATE: 4/2003 | JOB NO: A1348 | | | | |
| | | | | SCALE: AS SHOWN | FILENAME: A1348GT.dwg | | | | | |




| NO. | REVISION DESCRIPTION | BY | DATE |
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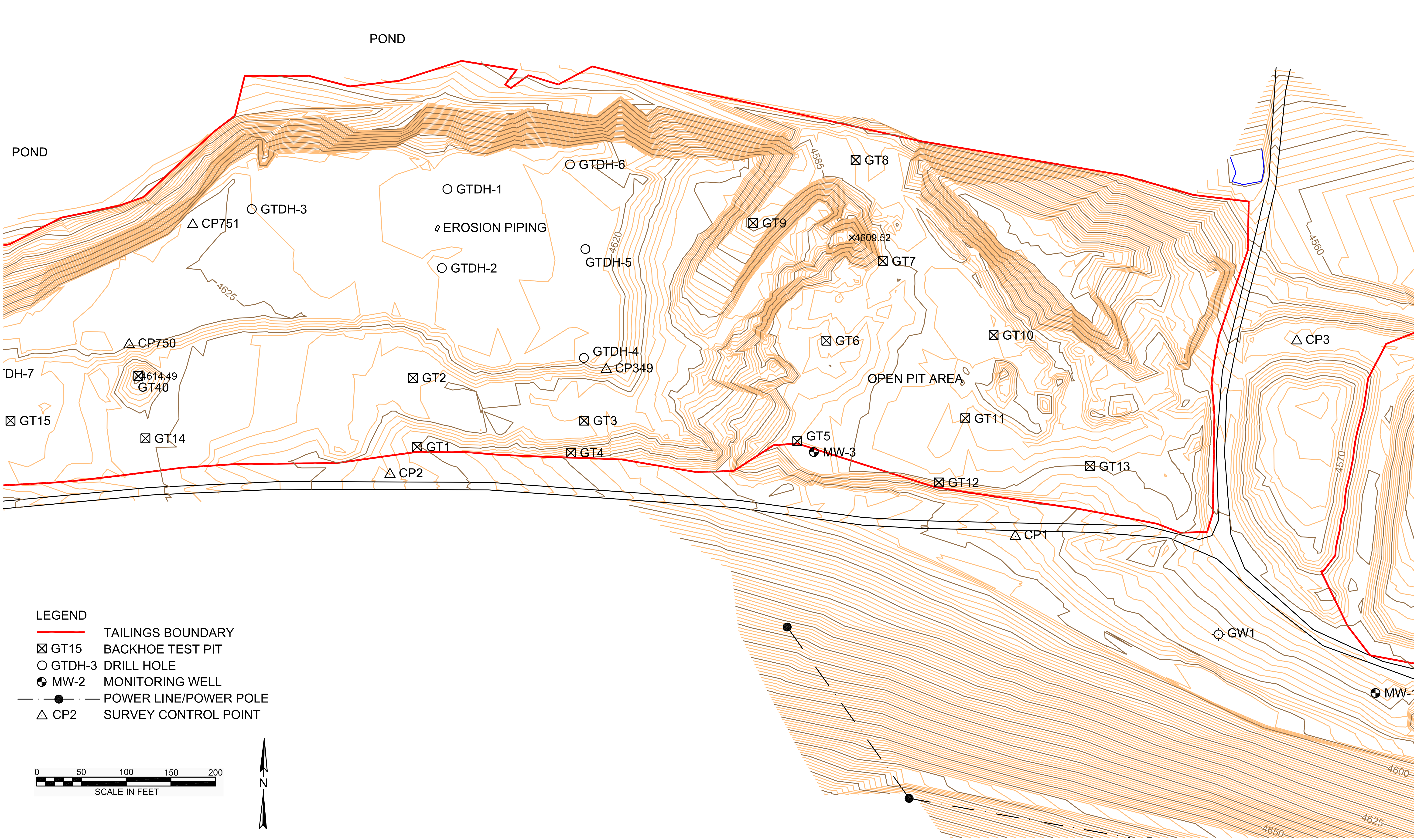
SCALE: AS SHOWN | FILENAME: A1348GT.dwg

MONTANA DEQ/MINE WASTE CLEANUP BUREAU
SILVER CREEK DRAINAGE PROJECT
LEWIS & CLARK COUNTY, MONTANA

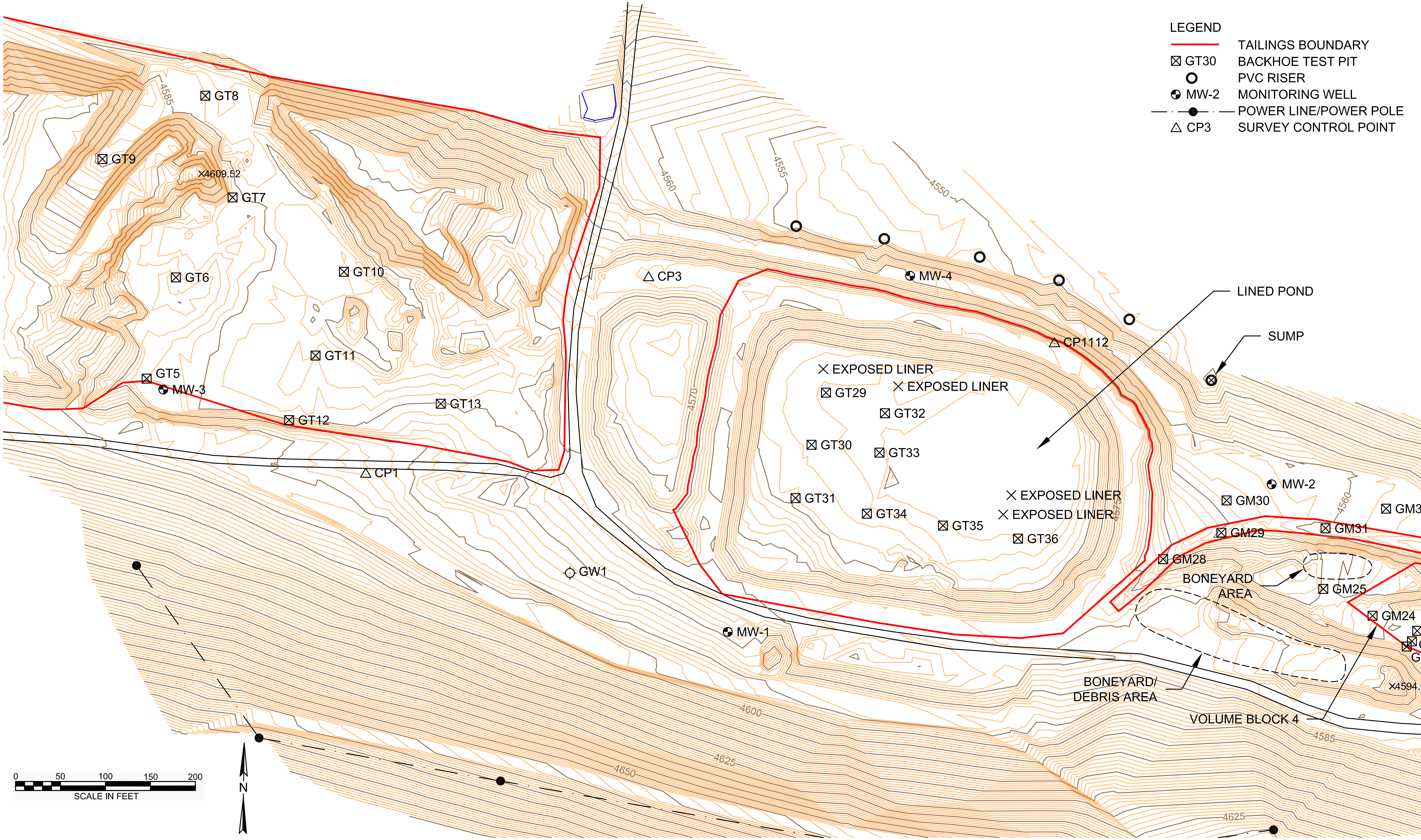
Olympus Technical Services, Inc.

WEST END OF GOLDSIL TAILINGS

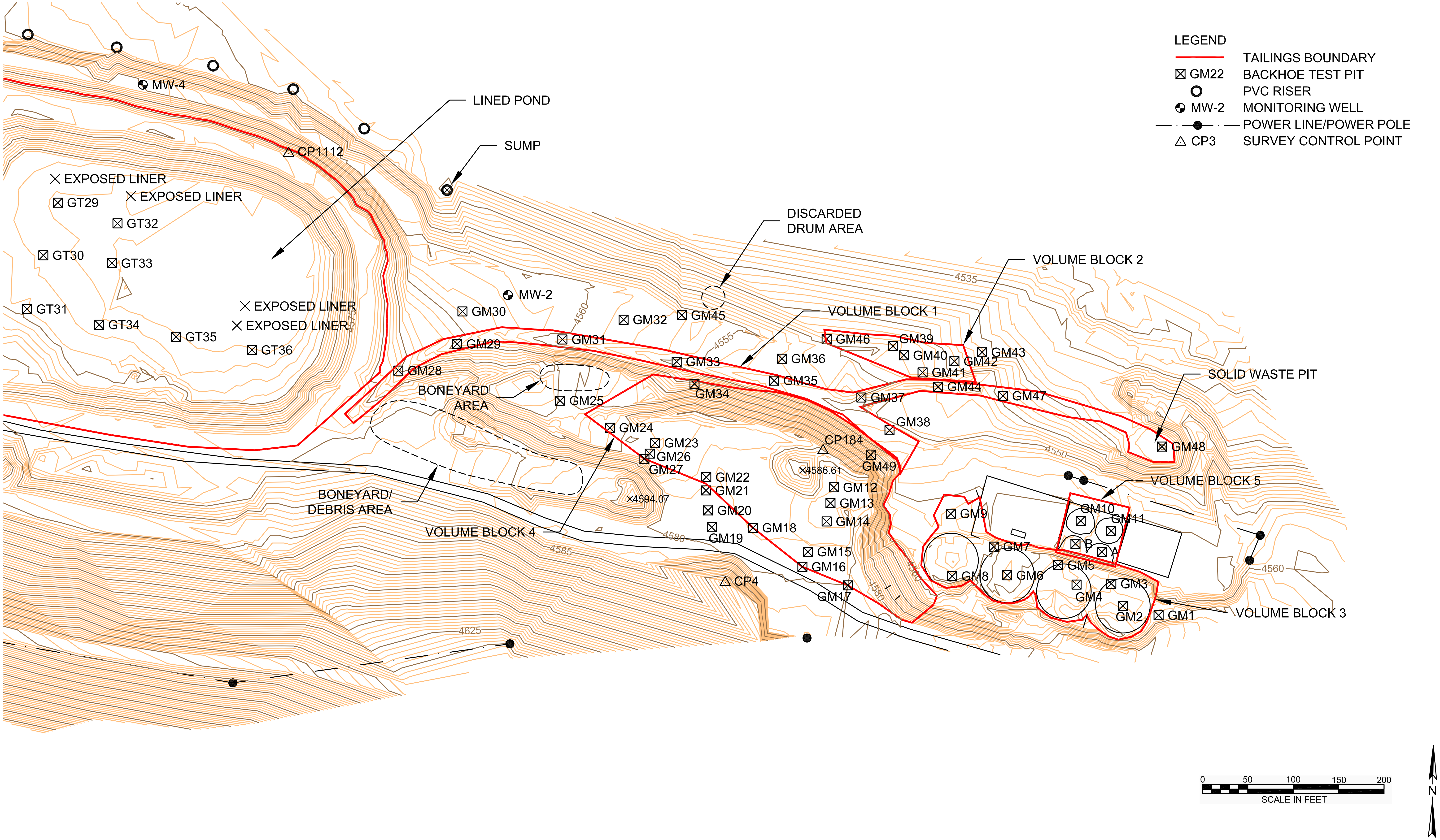
FIGURE 3-3




| NO. | REVISION DESCRIPTION | BY | DATE | DESIGN: | DRAWN: KSR | CHECKED: CRS | MONTANA DEQ/MINE WASTE CLEANUP BUREAU<br>SILVER CREEK DRAINAGE PROJECT<br>LEWIS & CLARK COUNTY, MONTANA | Olympus Technical Services, Inc. | CENTRAL PORTION OF GOLDSIL TAILINGS | FIGURE 3-4 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | APPROVED: | DATE: 4/2003 | JOB NO: A1348 | | | | |
| | | | | SCALE: AS SHOWN | FILENAME: A1348GT.dwg | | | | | |




| NO. | REVISION DESCRIPTION | BY | DATE | DESIGN: | DRAWN: KSR | CHECKED: CRS | MONTANA DEQ/MINE WASTE CLEANUP BUREAU<br>SILVER CREEK DRAINAGE PROJECT<br>LEWIS & CLARK COUNTY, MONTANA | Olympus Technical Services, Inc. | GOLDSIL MILLSITE<br>LINED TAILINGS IMPOUNDMENT | FIGURE<br>3-5 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | APPROVED: | DATE: 4/2003 | JOB NO: A1348 | | | | |
| | | | | SCALE: AS SHOWN | FILENAME: A1348GT.dwg | | | | | |




| | | | | | | | |
|---|---|---|---|---|---|---|---|
| NO. | REVISION DESCRIPTION | BY | DATE | DESIGN: | DRAWN: KSR | CHECKED: CRS | MONTANA DEQ/MINE WASTE CLEANUP BUREAU<br>SILVER CREEK DRAINAGE PROJECT<br>LEWIS & CLARK COUNTY, MONTANA |
| | | | | APPROVED: | DATE: 4/2003 | JOB NO: A1348 | |
| | | | | SCALE: AS SHOWN | FILENAME: A1348GT.dwg | | |

Olympus Technical Services, Inc.

GOLDSIL MILLSITE AREA

FIGURE 3-6

The main Goldsil tailings volume was compared with a historic volume estimate by Consulting Mining Engineer L.S. Ropes that was completed in 1935 (Ropes, 1935). The volume estimate was completed as part of a feasibility study for reprocessing tailings associated with the St. Louis and Drumlummon mines. The Goldsil tailings were referred to by Ropes as the "cyanide dump". As part of the early feasibility study, the cyanide dump was drilled and sampled on a 100 foot by 100 foot grid. Ropes reported the cyanide dump tailings quantity as 781,500 tons. At the reported tailings density of 20 cubic feet per ton, this is equivalent to approximately 578,900 cubic yards. This is more than the 458,430 cubic yards estimated by Olympus. However, Ropes' estimate was completed before tailings were removed from the open pit area at the west end of the Goldsil tailings. Olympus estimated that the volume of tailings removed from the open pit area was between 108,000 and 178,000 cubic yards. Adding that to the current estimate gives a volume range of 566,430 to 636,430 cubic yards, which compares well with Ropes 1935 volume estimate. Production records indicate that an additional 57,057 tons of ore were processed at the Drumlummon mill from 1936 through 1948 (McClernan, 1983). This would have resulted in approximately another 42,000 cubic yards of tailings, although it is not known to which tailings pile they would have been discharged.

The tailings are generally moderately to well vegetated with grasses, shrubs and trees. The composition of the tailings in the western end of the Goldsil tailings pile also suggests that tailings in this area may have been subjected to secondary processing. The tailings contain a mixture of fine tailings sediment, gravel and some rock. These tailings may have been drag-lined out of the Silver Creek drainage for reprocessing, possibly during the Argo Mill era when tailings were reprocessed by cyanide vat leaching method.

Test pits and drill holes were used to evaluate the tailings contained in the main Goldsil tailings pile (test pits GT-1 through GT-28; GT-37 through GT-40; and drill holes GTDH-1 through GTDH- 9), the Goldsil lined tailings pond and berm area (test pits GT-29 through GT-36), the Goldsil drainage ditch and terrace immediately to the north (test pits GM-28 through GM-48), the Goldsil mill area (test pits GM -1 through GM-11), and the Goldsil ramp area (test pits GM-12 through GM-25 and GM-49). The following field observations are summarized from test pit and drill hole observations.

The eastern end of the main Goldsil tailings pile is located to the west of the lined tailings pond. The main Goldsil tailings are composed predominantly of light tan to tan, fine-grained, silty sand. The finer grained tailings may show floury texture which when disturbed tends to be a source of dust. Lesser lenses or thin layers of tan clayey silt are generally slightly moist and when excavated appear as blocky chunks in the silty sand. The tailings range from massive to well layered where layers are usually thin and near horizontal in orientation. The native soils below the tailings are generally characterized as dark brown sandy loam with abundant subangular to angular rock generally ≤ 12-inch diameter. These materials are probably colluvium generated from the steep slopes located to the south of the tailings area. In some areas, the tailings appear to be deposited on placer tailings consisting of sand, gravel and rounded rock debris generally ≤ 12-inch diameter. The native materials below the tailings generally do not show any iron oxide (FeOx) except for minor occurrences where yellow brown FeOx may be present.

Black charcoal chunks generally ≤ 2-inches in diameter are conspicuously present in some areas of the Goldsil tailings. They can be observed in the vertical walls of the open pit mine area and in many of the test pits excavated in the eastern half of the tailings pile. The almost disseminated nature of the charcoal suggests that it may have been deposited along with the tailings slurry and not be related to a forest fire event. The source of the charcoal may well be the wood used as an energy source in the early mill operations (i.e., boilers). Similar charcoal materials were noted in the exposed cut faces of the large waste rock pile located immediately to the west of the Drumlummon mill foundation.

The west end of the Goldsil tailings pile is commonly composed of silty sand tailings along with gravel and some rock. The amount of gravel and rock associated with the tailings in this area is unusual in that it is not just surficial, suggesting that the tailings may have been disturbed for secondary processing. Historical references (Olympus, 2002) indicate that the Argo mill was operated exclusively for reprocessing of tailings presumably generated from the Drumlummon tailings. The amount of gravel and rock in the tailings suggest that they may have been excavated from their original deposition site using some sort of drag-line type operation.

In general, most of the Goldsil tailings are dry with the exception of test pits and/or hand auger drill holes located near the extreme northern boundary of the tailings pile, i.e. in the area of test pits (GT-21 and GT-22) and auger holes (GT-37, GT-38, GT-39, GT-41 and GT-42). Six samples of Goldsil tailings were collected from test pits and geoprobe drill cores for particle size analysis. The samples were selected to provide for a representative areal distribution and to characterize the mill tailings at different depths. The laboratory results are summarized in Table 3-3. The analytical results indicate that the Goldsil tailings are composed predominantly of silty sand with lesser sandy silt. The soil textures are characterized as sandy loam, silty loam and loam.

The tailings contained in the lined tailings pond, within the lined ditch running from the tailings pond to the Goldsil millsite area and on the terrace immediately to the north of the drainage ditch are generally light tan, silty sands. In the lined tailings pond, two areas representing discharge points are generally thicker and coarser grained in that they contain more sand than the silty sand tailings located to the north of the discharge points. The integrity of the PVC liners containing tailings in both the pond and drainage ditch areas is poor. Numerous puncture holes or tears were evident prior to any test pit construction. In both cases, it appears that the PVC liners were placed upon a heterogenous mixture of sand and gravel with generally abundant angular to subrounded rock ≤ 12-inch diameter. Test pits located in the western berm of the lined tailings pond indicate that silty sand tailings were mixed with alluvium in the upper five feet of the berm and tailings were placed on the inboard side of the berm. It appears that tailings may have been used as a fine-grained additive for gradation and as a sealant for the berm.

The tailings contained in the Goldsil mill area are generally grayish white to light tan, silty sand containing minor red brown to orange brown FeOx especially near the subsurface, rusted, steel tank bottom. Some minor steel piping was observed in the test pits constructed along the berm between the mill foundation and the former vat leach tank area. The native surface which is probably composed of fill in the mill area consists of dark brown sandy loam containing gravel and rock debris generally ≤ 6-inch diameter. Minor metal debris was observed in some of the subgrade fill materials. The western-most former vat leach tank area (test pit GM-8) contains a small patch of willows and the tailings were moist down to a depth of 4.4 feet at which the metal tank bottom was intersected. The white to light gray, silty sand tailings associated with the former vat areas within the main mill foundation are generally thin at ≤ 1.4 feet maximum thickness.

**Table 3-3. Mill Tailings Particle Size Results**

| Sample ID | Weight Percent Retained | | | | | Percent Finer by Weight | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Gravel | Sand | | | Silt/Clay | Gravel | Sand | | | Silt/Clay | | | | |
| Sieve Size | 3/4-in | #4 | #10 | #40 | #200 | 3/4-in | #4 | #10 | #40 | #200 | Percent | Percent | Percent | Soil |
| Opening (Inches) | 0.75 | 0.187 | 0.0661 | 0.0106 | 0.0029 | 0.75 | 0.187 | 0.0661 | 0.0106 | 0.0029 | Sand | Silt | Clay | Texture |
| GT19 0-2.3 | <0.1 | 0.1 | 0.1 | 3.7 | 74.7 | 100 | 99.9 | 99.8 | 96.1 | 21.4 | 76 | 18 | 6 | Sandy Loam |
| GTDH9 15-20 | 2.2 | 2.6 | 2.6 | 7 | 65.9 | 97.8 | 95.2 | 92.6 | 85.6 | 19.7 | 72 | 22 | 6 | Sandy Loam |
| GTDH2 20-25 | 0.1 | <0.1 | 0.1 | 1 | 71.8 | 99.9 | 99.9 | 99.8 | 98.8 | 27 | 62 | 32 | 6 | Sandy Loam |
| GTDH2 0-5 | <0.1 | <0.1 | <0.1 | 0.1 | 30.8 | 100 | 100 | 100 | 99.9 | 69.1 | 28 | 56 | 16 | Silty Loam |
| DT10 0-3.7 | <0.1 | <0.1 | <0.1 | 0.2 | 71.3 | 100 | 100 | 100 | 99.8 | 28.5 | 65 | 29 | 6 | Sandy Loam |
| DT10 3.7-10 | <0.1 | <0.1 | <0.1 | <0.1 | 3.3 | 100 | 100 | 100 | 100 | 96.7 | 14 | 76 | 10 | Silty Loam |
| GM12 0-10 | <0.1 | 0.1 | 0.4 | 3.4 | 52.2 | 100 | 99.9 | 99.5 | 96.1 | 43.9 | 44 | 42 | 14 | Loam |
| GM26 0-3.8 | 5.3 | 3.2 | 3.2 | 9.7 | 35 | 94.7 | 91.5 | 88.3 | 78.6 | 43.6 | 38 | 48 | 14 | Loam |

## LEGEND

GT - Goldsil Tailings backhoe test pit sample
GTDH - Goldsil Tailings geoprobe drill hole sample
GM - Goldsil Mill Tailings backhoe test pit sample
DT - Drumlummon Tailings backhoe test pit sample

The ramp area portion of the Goldsil tailings is located immediately to the west of the Goldsil millsite. The concrete retaining wall marks the eastern edge of the ramp tailings area. Backhoe test pits GM-12 through GM-14 were in the thicker portion of the ramp tailings area and did not intersect the native surface below the tailings. Pit depths ranged from 10 feet to 13.5 feet. Test pits GM-15, GM-18 and GM-22 intersected vertical, wooden crib walls that most likely were constructed as a tailings retaining wall when the tailings impoundment was built. Test pits indicate that the crib walls form the contact between tailings and native materials. Some steel cable, iron debris and 2-wire electric cable are associated with the wooden crib walls. The tailings are generally grayish white to light tan, silty sand and may contain some clayey silt near the lower contact with native materials. The native soils are generally composed of a dark brown, sandy loam with some gravel and variable amounts of rock debris generally ≤ 10-inch diameter. The native soils in contact with tailings did not contain any significant concentration of FeOx.

Representative samples were collected from Geoprobe drill cores, vertical channel samples taken from test pit walls or from grab samples collected from test pit excavation stockpiles. Individual samples were collected based on similar geologic characteristics. One hundred seventeen tailings samples and seventeen representative composite tailings samples were collected from the Goldsil tailings area for XRF screening. In addition, fourteen native soil samples and three composite native soils were collected for XRF screening. The Goldsil tailings (GT) qualitative to semi-quantitative XRF range and mean concentration results for the principal elements of interest are as follows: Ag (84-207 ppm and 151.4 ppm), As (16-88 ppm and 36.2 ppm ), Ba (395-898 ppm and 561.1 ppm), Cd (no detection), Cr (no detection), Cu (35-290 ppm and 135.5 ppm), Fe (2,980-13,260 ppm and 5,661.6 ppm), Hg (21-173 ppm and 81.1 ppm), Mn (160-980 ppm and 553.2 ppm), Ni (49-368 ppm and 166.2 ppm), Pb (44-335 ppm and 185.6 ppm), Sb (13-103 ppm and 45.3 ppm), and Zn (83-562 ppm and 254.3 ppm). The Goldsil mill and ramp tailings area (GM) XRF range and mean concentration results for the same element suite of interest are as follows: Ag (no detection), As (15-48 ppm and 31.4 ppm), Cd (no detection), Cu (29-144 ppm and 67.0 ppm), Cr (no detection), Fe (3,910-8,390 ppm and 5,998.0 ppm), Hg (20-100 ppm and 57.2 ppm), Mn (140-490 ppm and 283.3 ppm), Ni (51-162 ppm and 101.6 ppm), Pb (53-236 ppm and 146.9 ppm), Sb (43-89 ppm and 67.0 ppm), and Zn (137-435 ppm and 272.6 ppm). The XRF results are generally commensurate with the exception of Ag, Cu, and Mn which are significantly higher concentration in the Goldsil tailings area verses the Goldsil mill and ramp area. Laboratory analytical data for the seventeen composite samples and two duplicate samples collected from the entire Goldsil tailings area are summarized in Table 3-4. The tailings pH is alkaline ranging from 7.6 to 8.1 standard units (SU). The mean concentrations and the mean concentrations relative to background mean concentrations for analytes are summarized below. The mean concentrations from the laboratory quantitative analyses on representative composite samples generally corroborate the XRF screening mean concentration results with the exception of Cd which was not detected via XRF. For most parameters, the laboratory quantitative mean concentrations are higher than the XRF mean results except for Ag and Hg. Although the XRF method is not generally very efficient for Hg analysis, the XRF mean concentration results provide a reasonable estimate of the Goldsil tailings laboratory data mean concentration.

**Table 3-4. Laboratory Chemistry Results For Mill Tailings and Selected Subgrade Native Soils**

| Sample ID | pH (SU) | Ag (mg/Kg) | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | Total Cyanide (mg/Kg) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Goldsil Tailings** | | | | | | | | | | | | | | | | |
| 25-365-TP-1 | 8.1 | 15 | 22 | 42 | 2 | 6 | 122 | 6470 | 18 | 551 | <5 | 122 | 16 | 237 | 10.9 | Composite of GM-2 0-0.6;GM-4 0-2.1;GM-6 0-1.8;GM-8 0-4.4 |
| 25-365-TP-2 | 8.1 | | 30 | | 3 | | 157 | | 22 | | | 158 | | 376 | 21.1 | Composite of GM-3 0-2.1;GM-5 0-2.4;GM-7 0-2.3;GM-9 0-1.5 |
| 25-365-TP-3 | 7.9 | | 34 | | 3 | | 185 | | 66 | | | 197 | | 385 | 0.6 | Composite of GM-12 0-10;GM-13 0-11.5;GM-14 0-13.5;GM-15 0-14.6 |
| 25-365-TP-4 | 7.6 | | 39 | | 3 | | 180 | | 60 | | | 201 | | 396 | <0.5 | Composite of GM-18 0-13.8;GM-22 0-12.4;GM-26 0-3.8 |
| 25-365-TP-5 | 7.9 | | 38 | | 3 | | 188 | | 66 | | | 207 | | 414 | <0.5 | Duplicate split of 25-365-TP-3 |
| 25-365-TP-6 | 8.0 | 9 | 28 | 44 | 4 | <5 | 130 | 6680 | 25 | 714 | <5 | 154 | 16 | 308 | <0.5 | Composite of GT-6 0-7.1;GT-7 0-9.0;GT-9 0-8.4 |
| 25-365-TP-7 | 7.9 | 14 | 27 | 35 | 4 | <5 | 114 | 6660 | 25 | 621 | <5 | 137 | 17 | 260 | <0.5 | Composite of GT-10 0-6.7;GT-13 0-7.8 |
| 25-365-TP-8 | 7.9 | | 33 | | 4 | | 154 | | 43 | | | 160 | | 364 | 0.8 | Composite of GT-2 0-16.4;GT-3 0-16.8 |
| 25-365-TP-9 | 7.8 | | 37 | | 4 | | 173 | | 57 | | | 201 | | 386 | 0.7 | Composite of GT-14 0-6.6;GT-15 0-5.0 |
| 25-365-TP-10 | 8.0 | | 31 | | 4 | | 154 | | 36 | | | 153 | | 299 | <0.5 | Composite of GT16 0-15.2;GT-17 0-14.6;GT-20 0-15.2 |
| 25-365-TP-11 | 7.6 | 12 | 40 | 70 | 3 | 5 | 220 | 8790 | 86 | 830 | <5 | 242 | 15 | 507 | 2.8 | Composite of GTDH-1 0-5;GTDH-6 0-5;GTDH-3 0-5 |
| 25-365-TP-12 | 7.7 | 13 | 45 | 75 | 3 | 6 | 240 | 9720 | 96 | 889 | 5 | 268 | 15 | 557 | 6.8 | Composite of GTDH-2 0-5;GTDH-4 0-5;GTDH-5 0-5 |
| 25-365-TP-13 | 8.0 | 15 | 32 | 49 | 3 | <5 | 190 | 6160 | 57 | 788 | <5 | 187 | 12 | 330 | 0.9 | Composite of GTDH-1 15-20;GTDH-6 15-20;GTDH-3 15-20 |
| 25-365-TP-14 | 7.9 | 20 | 31 | 51 | 3 | <5 | 187 | 6630 | 84 | 789 | <5 | 208 | 15 | 374 | 2.3 | Composite of GTDH-2 15-20;GTDH-4 15-20;GTDH-5 15-20 |
| 25-365-TP-15 | 7.9 | 32 | 26 | 44 | 3 | <5 | 190 | 4970 | 48 | 593 | <5 | 177 | 17 | 300 | 3.1 | Composite of GTDH-1 29-34;GTDH-6 30-35;GTDH-3 30-35 |
| 25-365-TP-16 | 7.8 | 43 | 29 | 44 | 3 | <5 | 199 | 5690 | 53 | 685 | <5 | 210 | 15 | 357 | 10.2 | Composite of GTDH-2 30-34;GTDH-4 30-33.1;GTDH-5 30-35 |
| 25-365-TP-17 | 8.0 | 18 | 24 | 35 | 2 | <5 | 144 | 5490 | 28 | 553 | <5 | 143 | 13 | 271 | 1.0 | Composite of GTDH-7 5-10;GTDH-8 5-10;GTDH-9 5-10 |
| 25-365-TP-18 | 8.0 | 18 | 26 | 49 | 2 | <5 | 133 | 5810 | 39 | 629 | <5 | 137 | 14 | 257 | 0.6 | Composite of GTDH-7 15-19.4;GTDH-8 15-20;GTDH-9 15-20 |
| 25-365-TP-19 | 7.9 | 22 | 33 | 43 | 3 | <5 | 192 | 6210 | 54 | 751 | <5 | 192 | 15 | 353 | 2.9 | Duplicate split of 25-365-TP-13 |
| **Maximum** | 8.1 | 43 | 45 | 75 | 4 | 6 | 240 | 9720 | 96 | 889 | | 268 | 17 | 557 | 21.1 | |
| **Minimum** | 7.6 | 9 | 22 | 35 | 2 | <5 | 114 | 4970 | 18 | 551 | | 122 | 12 | 237 | <0.5 | |
| **Mean** | 7.9 | 19.3 | 31.8 | 48.4 | 3.1 | | 171.2 | 6606.7 | 50.7 | 699.4 | | 181.8 | 15.0 | 354.3 | 3.5 | |
| **No. Samples** | 19 | 12 | 19 | 12 | 19 | 12 | 19 | 12 | 19 | 12 | 12 | 19 | 12 | 19 | 19 | |
| **Goldsil Tailings Subgrade Native Soils** | | | | | | | | | | | | | | | | |
| 25-365-SS-1 | 7.5 | | 54 | | <1 | | 24 | | 2 | | | 20 | | 81 | 2.4 | Composite of GM-3 2.1-3.1;GM-5 2.4-3.4;GM-7 2.3-3.3;GM-9 1.5-2.5 |
| 25-365-SS-2 | 7.8 | | 26 | | <1 | | 16 | | <1 | | | 11 | | 57 | <0.5 | Split of GM-27 |
| 25-365-SS-3 | 7.4 | | 19 | | 3 | | 34 | | 6 | | | 15 | | 73 | 0.8 | Composite of GT-1 1.2-3.6;GT-4 2.8-5.0 |
| 25-365-SS-4 | 7.6 | | 28 | | <1 | | 62 | | 6 | | | 16 | | 69 | 7.9 | Composite of GTDH-1 42.55-43.55;GTDH-6 42.65-44.0;GTDH-3 37.75-38.85;GTDH-4 33.1-34.0 |
| **Drumlummon Tailings** | | | | | | | | | | | | | | | | |
| 25-024-TP-1 | 7.7 | 14 | 10 | 51 | <1 | 11 | 67 | 9100 | 1 | 512 | 7 | 73 | <5 | 110 | <0.5 | Composite of DT-4 0-5.0;DT-12 4.2-6.4;DT-15 4.7-6.6 |
| 25-024-TP-2 | 7.9 | 21 | 14 | 56 | <1 | 7 | 79 | 7860 | <1 | 402 | 5 | 45 | 7 | 115 | <0.5 | Composite of DT-1 7.8-9.5;DT-10 3.7-10.0 |
| 25-024-TP-3 | 7.9 | 10 | <5 | 40 | <1 | 8 | 23 | 6380 | <1 | 477 | <5 | 37 | <5 | 64 | <0.5 | Composite of DT-2 0-4.0;DT-8 0-5.8;DT-12 0-4.2:DT-15 0-4.7 |
| 25-024-TP-4 | 7.9 | 20 | 20 | 35 | <1 | <5 | 74 | 7360 | 1 | 414 | <5 | 79 | 8 | 124 | <0.5 | Composite of DT-1 4.8-7.8;DT-3 3.7-7.4;DT-5 0-8.9 |
| 25-024-TP-5 | 7.9 | 17 | 12 | 55 | <1 | 7 | 69 | 7720 | <1 | 386 | <5 | 38 | 5 | 100 | <0.5 | Duplicate split of 25-024-TP-2 |
| **Maximum** | 7.9 | 21 | 20 | 56 | <1 | 11 | 79 | 9100 | 1 | 512 | 7 | 79 | 8 | 124 | <0.5 | |
| **Minimum** | 7.7 | 10 | 10 | 35 | <1 | 7 | 23 | 6380 | <1 | 386 | <5 | 37 | <5 | 64 | <0.5 | |
| **Mean** | 7.9 | 16.4 | 11.7 | 47.4 | | 7.1 | 62.4 | 7684.0 | | 438.2 | | 54.4 | 5.0 | 102.6 | | |
| **No. Samples** | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | |
| **Upper Pond Tailings Area** | | | | | | | | | | | | | | | | |
| 25-SCD-TP-7 | 8.0 | | 27 | | 3 | | 164 | | 32 | | | 163 | | 334 | 0.5 | Composite of UP6 0-5;UP7 0-3.8:LP8 0-1.4 |
| 25-SCD-TP-8 | 7.9 | | 54 | | 4 | | 301 | | 140 | | | 331 | | 686 | 1.0 | Composite of UP2 5.5-7;UP3 5.1-7.4:UP4 0-6.1;UP8 9.4-10.5 |
| **Maximum** | 8.0 | | 54 | | 4 | | 301 | | 140 | | | 331 | | 686 | 1 | |
| **Minimum** | 7.9 | | 27 | | 3 | | 164 | | 32 | | | 163 | | 334 | 0.5 | |
| **Mean** | 8.0 | | 40.5 | | 3.5 | | 232.5 | | 86.0 | | | 247.0 | | 510.0 | 0.8 | |
| **No. Samples** | 2 | | 2 | | 2 | | 2 | | 2 | | | 2 | | 2 | 2 | |
| **Upper Pond Area Subgrade Native Soil** | | | | | | | | | | | | | | | | |
| 25-SCD-TP-9 | 7.7 | | 31 | | <1 | | 84 | | 25 | | | 50 | | 90 | <0.5 | Composite of UP1 3.9.4.9;UP2 7-8:UP4 6.1-7.8;UP7 3.8-4.8 |
| **Lower Pond Area Tailings** | | | | | | | | | | | | | | | | |
| 25-SCD-TP-5 | 8.0 | | 27 | | 2 | | 135 | | 37 | | | 132 | | 280 | 5.0 | Composite of LP1 0-5;LP2 0-5:LP4 0-5;LP6 2.5-5 |
| 25-SCD-TP-6 | 8.1 | | 29 | | 2 | | 115 | | 27 | | | 107 | | 231 | 2.0 | Composite of LP1 9-14;LP4 5-10:LP6 5-8 |

**Table 3-4. Laboratory Chemistry Results For Mill Tailings and Selected Subgrade Native Soils**

| Sample ID | pH (SU) | Ag (mg/Kg) | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | Total Cyanide (mg/Kg) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Maximum** | 8.1 | | 29 | | 2 | | 135 | | 37 | | | 132 | | 280 | 5.0 | |
| **Minimum** | 8.0 | | 27 | | 2 | | 115 | | 27 | | | 107 | | 231 | 2.0 | |
| **Mean** | 8.1 | | 28.0 | | 2.0 | | 125.0 | | 32.0 | | | 119.5 | | 255.5 | 3.5 | |
| **No. Samples** | 2 | | 2 | | 2 | | 2 | | 2 | | | 2 | | 2 | 2 | |
| | | | | | | | | | | | | | | | | |
| **Middle Pond Area Tailings** | | | | | | | | | | | | | | | | |
| 25-SCD-TP-10 | 7.4 | | 22 | | 3 | | 98 | | 16 | | | 104 | | 215 | 4.1 | Composite of MP-2 0-5.8;MP-6 0-4.3;MP-7B 0-3.6;MP-9 0-3.4 |
| 25-SCD-TP-11 | 7.7 | | 25 | | <1 | | 79 | | 7 | | | 78 | | 166 | 23.9 | Composite of MP-3 6.5-7.4;MP-7B 3.6-4.6;MP-9 4.3-6.5 |
| 25-SCD-TP-12 | 7.7 | | 20 | | 2 | | 107 | | 26 | | | 114 | | 226 | 5.9 | Composite of MP-15 0-4.7;MP-16 0-2.5;MP-20 0-3.7 |
| 25-SCD-TP-13 | 7.7 | | 27 | | 2 | | 131 | | 26 | | | 147 | | 262 | 4.9 | Composite of MP-13 0-2.8;MP-16 2.5-4.2 |
| **Maximum** | 7.7 | | 27 | | 3 | | 131 | | 26 | | | 147 | | 262 | 23.9 | |
| **Minimum** | 7.4 | | 20 | | <1 | | 79 | | 7 | | | 78 | | 166 | 4.1 | |
| **Mean** | 7.6 | | 23.5 | | 1.9 | | 103.8 | | 18.8 | | | 110.8 | | 217.3 | 9.7 | |
| **No. Samples** | 4 | | 4 | | 4 | | 4 | | 4 | | | 4 | | 4 | 4 | |
| | | | | | | | | | | | | | | | | |
| **Middle Pond Area Subgrade Native Soil** | | | | | | | | | | | | | | | | |
| 25-SCD-SS-1 | 7.8 | | 49 | | <1 | | 21 | | <1 | | | 14 | | 51 | 2.1 | Composite of MP-3 7.4-7.9;MP-6 5.2-6.0;MP-9 6.5-7.5 (native soil) |
| | | | | | | | | | | | | | | | | |
| **Drumlummon Millsite Tailings** | | | | | | | | | | | | | | | | |
| 25-SCD-TP-1 | 7.9 | | 41 | | <2 | | 195 | | 1 | | | 173 | | 281 | 1.7 | Composite of clayey tailings from TP1-1 |
| 25-SCD-TP-2 | 8.0 | | 32 | | <2 | | 62 | | 1 | | | 115 | | 105 | 1.8 | Composite of silty sand tailings from TP1-2 and TP1-5 |
| 25-SCD-TP-3 | 7.3 | | 21 | | <2 | | 64 | | 9 | | | 74 | | 78 | <0.2 | Composite of fine sand tailings from TP2-1 and TP2-1 |
| 25-SCD-TP-4 | 7.7 | | 18 | | <2 | | 53 | | 9 | | | 77 | | 104 | <0.2 | Composite of sandy tailings from TP3-2 and TP-3-3 |
| 25-024-DMTP1 | 8.2 | 8 | 28 | 88 | <1 | 11 | 114 | 10600 | <1 | 474 | <5 | 147 | 10 | 335 | 24.8 | Tailings from Drumlummon Mill foundation |
| **Maximum** | 8.2 | | 41 | | <2 | | 195 | | 9 | | | 173 | | 335 | 24.8 | |
| **Minimum** | 7.3 | | 18 | | <2 | | 53 | | <1 | | | 74 | | 78 | <0.2 | |
| **Mean** | 7.82 | | 28.0 | | | | 97.6 | | 4.1 | | | 117.2 | | 181 | 5.70 | |
| **No. Samples** | 5 | | 5 | | 5 | | 5 | | 5 | | | 5 | | 5 | 5 | |

Note: Statistics - one half the lower detection limit is used where below detection limit samples are included in the mean calculation

**Goldsil Tailings Mean Element Concentrations Compared to Background** (quantitative laboratory results)

All Results in mg/kg

| Ag | As | Ba | Cd | Cr | Cu | Fe | Hg | Mn | Ni | Pb | Sb | Zn | T CN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.3 | 31.8 | 48.4 | 3.1 | 3.3 | 171.2 | 6606.7 | 50.7 | 699.4 | 2.7 | 181.8 | 15.0 | 354.3 | 3.5 |
| *>7.7x* | *1.5x* | *0.3x* | *>6.2x* | *0.28x* | *5.0x* | *0.5x* | *>101.4* | *1.4x* | *0.30x* | *16.1x* | *3.1x* | *5.2x* | |

Note *Analytes Ag, Cd, and Hg were analyzed but not detected in background samples; used ½ detection limit for statistics*
*Total cyanide was not analyzed in background soil*

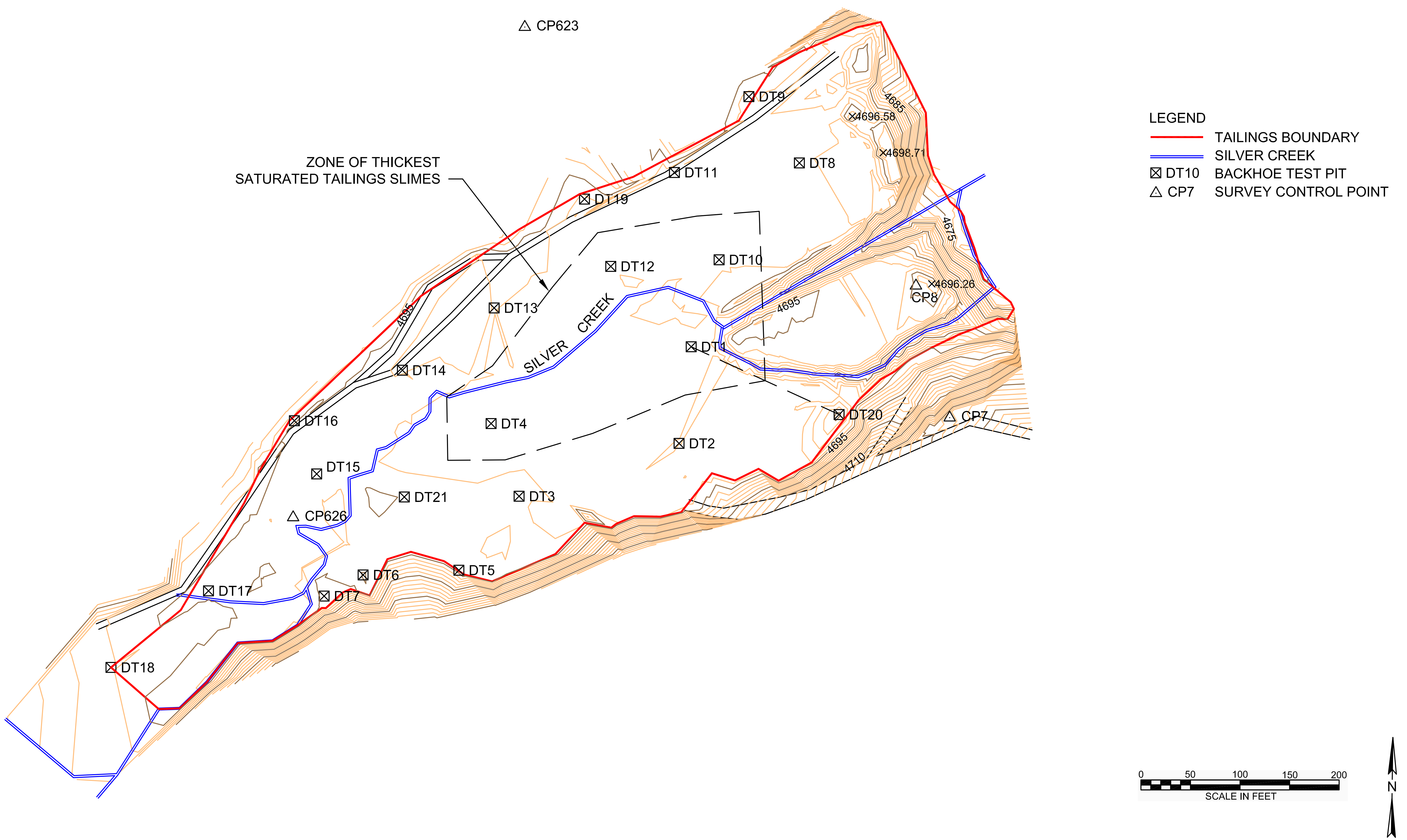
The analytes with an average concentration greater than or equal to three times the average background soil concentration include: Ag, Cd, Cu, Hg, Pb, Sb and Zn. Although total cyanide was not compared to average background soil because the parameter was not analyzed in these soils, the tailings mean concentration of 3.5 mg/Kg and a maximum concentration of 21 mg/Kg is elevated.

The native soil samples associated with the Goldsil tailings were analyzed for paste pH, As, Cd, Cu, Pb, Hg, Zn and total cyanide. The data indicate that concentrations are generally in the range of background soil concentrations with the exception of Hg and total cyanide. Although the Hg concentrations (2 to 6 mg/Kg) detected in the native soils beneath the tailings are significantly lower than the average concentration of 50.7 mg/Kg in the tailings, they are elevated. It is possible that some of the "native soils" may be placer tailings for it can be difficult differentiating placer tailings from colluvium or alluvium. Total cyanide ranges from no detection to 7.9 mg/Kg in the native soils and the detections indicate that some cyanide appears to be mobilizing into the top of the native soils. A single detection of Cd consistent with the tailings concentration was reported in the composite sample collected from native soils in test pits GT-1 and GT-4.

#### 3.2.1.2 Drumlummon Tailings Volume, Geology and Chemistry

The Drumlummon tailings pile is located in the SE¼ Section 32, Township 12 North and Range 5 West, Montana Principal Meridian (Figure 1-1). The tailings pile occurs within the Silver Creek drainage and its floodplain. Because of past tailings erosion problems, Silver Creek has been diverted into rock-lined channels in the area of the breached tailings dam to minimize sedimentation impacts from stormwater and snowmelt runoff events. With the exception of the areas near the breached tailings dam, the tailings pile is generally well vegetated with grasses and other shrubs and trees including willows. In the dam area, the Silver Creek channel is lined and the tailings pile is capped with rock to control erosion of tailings sediment.

The Drumlummon tailings volume was estimated using the detailed topographic survey of the tailings surface and the drill hole and test pit data (Figure 3-7). A total of 21 backhoe test pits were excavated in the tailings area. The volume estimate method is detailed in the Silver Creek Drainage Project Phase II Site Characterization Report (DEQ-MWCB/Olympus, 2003b). The estimated volume of the Drumlummon tailings pile is 59,780 cubic yards. The tailings plan area is 5.45 acres and the average tailings depth is 6.8 feet. The maximum tailings thickness measured in the test pits was 15 feet.

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DRUMLUMMON TAILINGS AREA

FIGURE 3-7

The tailings volume estimate was compared with a historic volume estimate by Consulting Mining Engineer L.S. Ropes that was completed in 1935 (Ropes, 1935). The volume estimate was completed as part of a feasibility study for reprocessing tailings associated with the St. Louis and Drumlummon mines. As part of the Ropes study, the Drumlummon tailings were drilled and sampled on a 50 foot by 50 foot grid. Ropes reported the Drumlummon tailings quantity as 57,500 tons. At the reported tailings density of 20 cubic feet per ton, this is equivalent to approximately 42,600 cubic yards. This is less than the nearly 60,000 cubic yards that are currently in the Drumlummon tailings area. However, production records indicate that an additional 57,057 tons of ore were processed at the Drumlummon mill from 1936 through 1948 (McClernan, 1983). This would have resulted in approximately another 42,000 cubic yards of tailings, although it is not known whether these tailings were discharged to the Drumlummon tailings pile or to some other location.

The Drumlummon tailings pile geology is based on observations made from 21 backhoe test pits (Figure 3-7). The tailings pile is comprised predominantly of light tan to tan silty sand with variable degrees of red to orange brown FeOx coloration. Lesser amounts of light greenish gray, silty sand tailings are present. The silty sand tailings are generally dry, but some areas may contain slight moisture. Thin bands, streaks and clots of moist silty clay may be present in the silty sand tailings. More clay-rich tailings slime zones are generally characterized by tan to bluish gray silty clay to clayey silt zones. The thicker tailings slime zones are commonly saturated causing very unstable pit walls in the backhoe excavations. The thicker tailings slime zones were intercepted in test pits DT1, DT4, DT10 and DT12. The areal extent of these pits indicate that the slime zone is located in the central portion of the tailings pile (Figure 3-7). The current Silver Creek channel traverses through this area.

The red to orange brown coloration in the Drumlummon tailings pile indicates that FeOx is present. Iron oxidation may be the result of oxidized ore mined from the upper portions of the vein system, primary sulfide oxidation in the tailings pile or a combination of both. Of all the tailings piles investigated in Phases I and II of the Silver Creek Drainage Project, the Drumlummon tailings pile contains the most iron oxide coloration.

The native surface below the tailings was intercepted in all of the test pits except for DT4 and DT10 in which saturated slimes caused major pit wall collapse. The native soils generally consist of light brown sandy gravel with rock up to 12-inch diameter. The rock is generally angular to subrounded, suggesting the native material is probably colluvium verses alluvium. The native sediments generally not did contain significant moisture. Some of this material may be related to placer operations that pre-dated the emplacement of the mill tailings. Iron oxide coloration in the native soils appears to be highly variable but generally minor in concentration with the exception of two pits, DT2 and DT12, where native sediments contain abundant orange brown FeOx.

Drumlummon tailings particle size analyses were conducted on samples collected from backhoe test pit DT10 and the results are summarized in Table 3-3. Laboratory analysis indicates that the predominant tailings texture is characterized as a sandy loam whereas the lesser slime-rich tailings are characterized as a silty loam containing ten percent clay.

Representative samples for chemical analyses were collected from vertical channel samples taken from the test pit wall or from grab samples collected from the test pit excavation stockpile. Individual samples were collected based on similar geologic characteristics. Twenty-two tailings samples and four representative composite tailings samples were collected from the Drumlummon tailings pile for XRF screening. In addition, five native soil samples were collected from below the tailings near the contact zone for XRF screening. The XRF results indicate that the principal elements of concern, i.e. As, Cd, Cu, Pb, Hg and Zn are either below analytical method detection limit or in low concentration. Laboratory analytical data for the four composite samples are summarized in Table 3-4. The tailings pH is alkaline ranging from 7.7 to 7.9 standard units (SU). The following are the mean concentration and enrichment relative to the background mean concentrations for each element:

**Drumlummon Mean Tailings Element Concentrations Compared to Background**
(quantitative laboratory results)

All Results in mg/kg

| Ag | As | Ba | Cd | Cr | Cu | Fe | Hg | Mn | Ni | Pb | Sb | Zn | T CN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 16.4 | 11.7 | 47.4 | a | 7.1 | 62.4 | 7,684 | b | 438.2 | c | 54.4 | 5.0 | 102.6 | a |
| *6.6x* | *0.6x* | *0.3x* | | *0.6x* | *1.8x* | *0.6* | | *0.9x* | | *4.8x* | 1.0x | *1.5x* | |

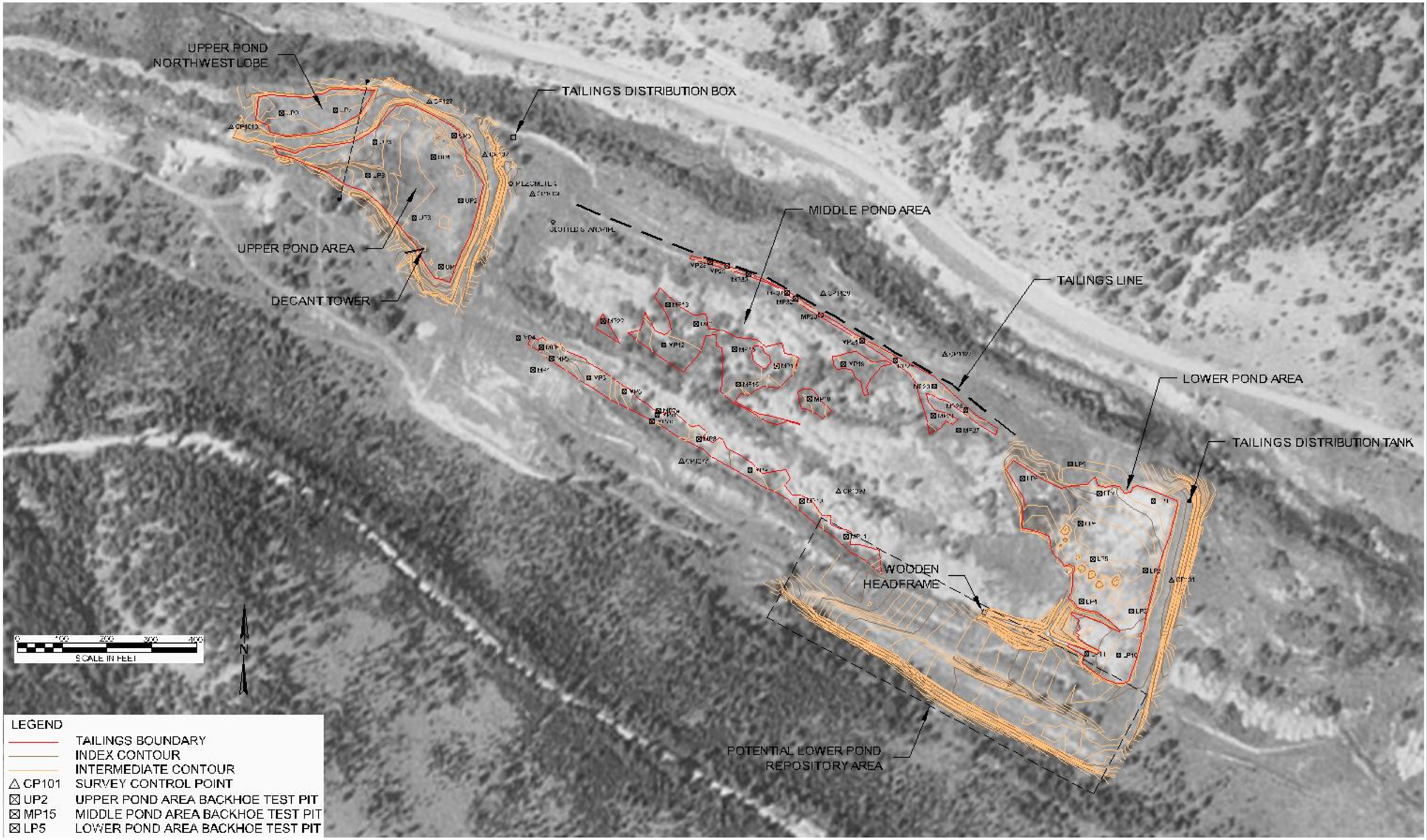
*a - Analyte Cd and total cyanide were not detected in tailings samples*
*b - Analyte Hg was detected at a maximum of 1mg/Kg in less than 50% of samples*
*c - Analyte Ni was detected at a maximum of 7mg/Kg in less than 50% of samples*

The laboratory quantitative analyses on representative composite samples corroborate the XRF screening results. The chemistry results indicate that the Drumlummon tailings contain low concentrations for the elements of concern. Silver and Pb were the only analytes with an average concentration greater than three times the average background soil concentration. Native soil samples were collected below the tailings pile from backhoe test pits DT2, DT3, DT8, DT12 and DT13. The five samples were analyzed via XRF and the results for the potential contaminants are below detection limit or are in low concentrations indicating that the native soils do not appear to be impacted by the mill tailings.

#### 3.2.1.3 Upper Pond Area Tailings Volume, Geology and Chemistry

The Upper Pond Area tailings pile is located in the SE¼ Section 34, Township 12 North and Range 5 West, Montana Principal Meridian (Figure 1-1). Some of the Upper Pond Area tailings were probably generated from the Goldsil mill operations in the 1970's. A tailings dam is constructed along the southeastern boundary and is tied into placer tailings berms to form an impoundment into which the tailings were deposited. The tailings dam is constructed of native materials which appear to have been excavated from an open cut immediately to the southeast of the tailings pond. The tailings are moderately well vegetated with grasses, sagebrush, some willows and weeds.

The location of the Upper, Middle and Lower Pond Areas are superimposed on an aerial photograph and are shown on Figure 3-8. A detailed survey of the Upper Pond tailings area was completed and the topographic map is shown on Figure 3-9. The Upper Pond area tailings volume was estimated using the detailed topographic survey of the tailings surface and the test pit data. The volume estimate method is detailed in the Silver Creek Drainage Project Phase II Site Characterization Report (DEQ-MWCB/Olympus, 2003b). The Upper Pond Area tailings volume is estimated at 17,400 cubic yards for the main tailings and 3,320 cubic yards for a smaller lobe located northwest of the main tailings. The tailings plan areas are 1.79 and 0.44 acres for the main tailings and northwest lobe, respectively. The average tailings depths are 6.03 and 4.72 feet for the main tailings and northwest lobe, respectively. The maximum tailings thickness measured in the test pits was 10.5 feet.

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| | | | | APPROVED: | DATE: 4/2003 | JOB NO: A1348 | | | FIGURE 3-8 |
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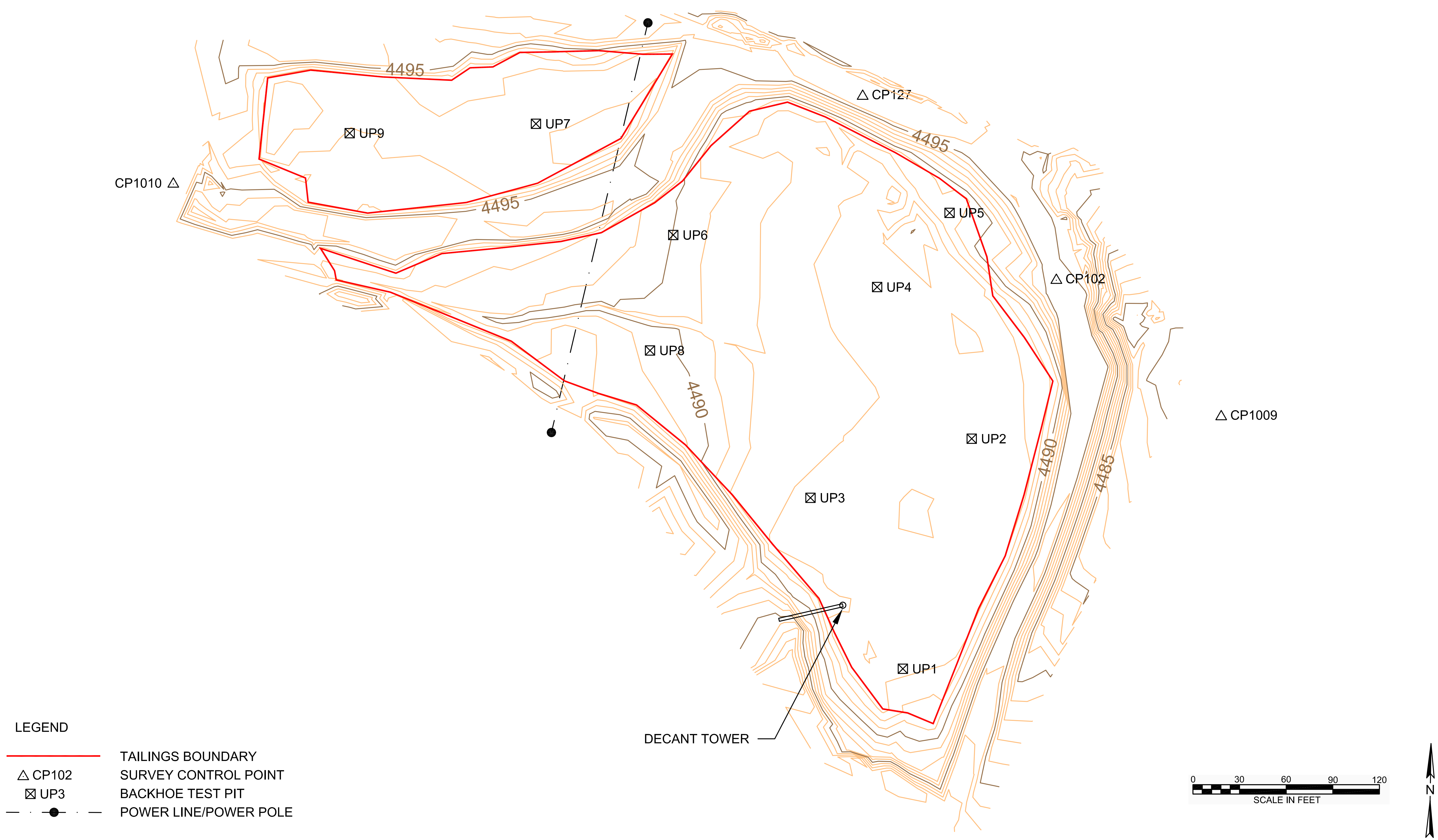


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TOPOGRAPHIC MAP OF THE UPPER POND AREA

FIGURE 3-9

A total of 8 test pits and one hand auger boring were excavated in the Upper Pond tailings. The tailings in the Upper Pond Area predominantly consist of very fine grained to fine grained, white to tan silty clay and clayey silt. The fine grained, floury texture of the tailings is a source for dust emissions if wind conditions are right when the tailings are disturbed. Lesser fine grained sand tailings may be present and some bluish gray to light green clay tailings slimes were observed in the thicker tailings zones, i.e. in test pit UP8. Orange brown to red brown FeOx was observed in some of the tailings and native soils. The tailings are commonly banded with thin layers which appear to be more silt or clay rich. The tailings range from dry to very moist. Based on the vegetation pattern, they may contain more water during higher precipitation periods. The native soils consist of dark brown sand and silt with gravel. Angular to subangular rock or rounded cobbles are present in some of the native soils intersected in test pits.

Representative samples were collected from vertical channel samples taken from test pit walls or from grab samples collected from the test pit excavation stockpiles. Individual samples were collected based on similar geologic characteristics. Fifteen tailings samples and two representative composite tailings samples were collected from the Upper Pond Area tailings for XRF screening. In addition, seven native soil samples and one composite native soil were collected for XRF screening. The Upper Pond Area tailings qualitative to semi-quantitative XRF range and mean concentration results for the principal elements of interest are as follows: Ag (no detection), As (19-113 ppm and 45.6 ppm ), Ba (614-861 ppm and 742.2 ppm), Cd (no detection), Cr (no detection), Cu (29-271 ppm and 137.8 ppm), Fe (4,850-15,800 ppm and 9,661.8 ppm), Hg (37-267 ppm and 134.4 ppm), Mn (170-1,000 ppm and 559.2 ppm), Ni (70-423 ppm and 194.4 ppm), Pb (88-588 ppm and 308.8 ppm), Sb (37-171 ppm and 97.0 ppm), and Zn (224-894 ppm and 523.1 ppm).

Laboratory analytical data for the two tailings and one native soil composite samples collected from the Upper Pond Area tailings are summarized in Table 3-4. A limited laboratory analytical suite consisting of pH, As, Cd, Cu, Hg, Pb, Zn and total cyanide was used for the Upper Pond Area tailings. These tailings were identified during the Phase I reconnaissance work in the Silver Creek Drainage Project and were analyzed according to the Phase I work analytical protocol. The tailings pH is alkaline ranging from 7.9 to 8.0 standard units (SU). The following are the mean concentration and enrichment relative to the background mean concentrations for each element.

**Upper Pond Area Mean Tailings Element Concentrations Compared to Background**
(quantitative laboratory results)

All Results in mg/kg

| As | Cd | Cu | Hg | Pb | Zn | T CN |
|---|---|---|---|---|---|---|
| 40.5 | 3.5 | 232.5 | 86.0 | 247.0 | 510.0 | 0.8 |
| *1.9x* | *>7.0x* | *6.8x* | *>172x* | *21.9x* | *7.4x* | *a* |

*a - Analyte total cyanide was not analyzed in background soils*
*Hg and Cd were not detected in background soils above detection limit*

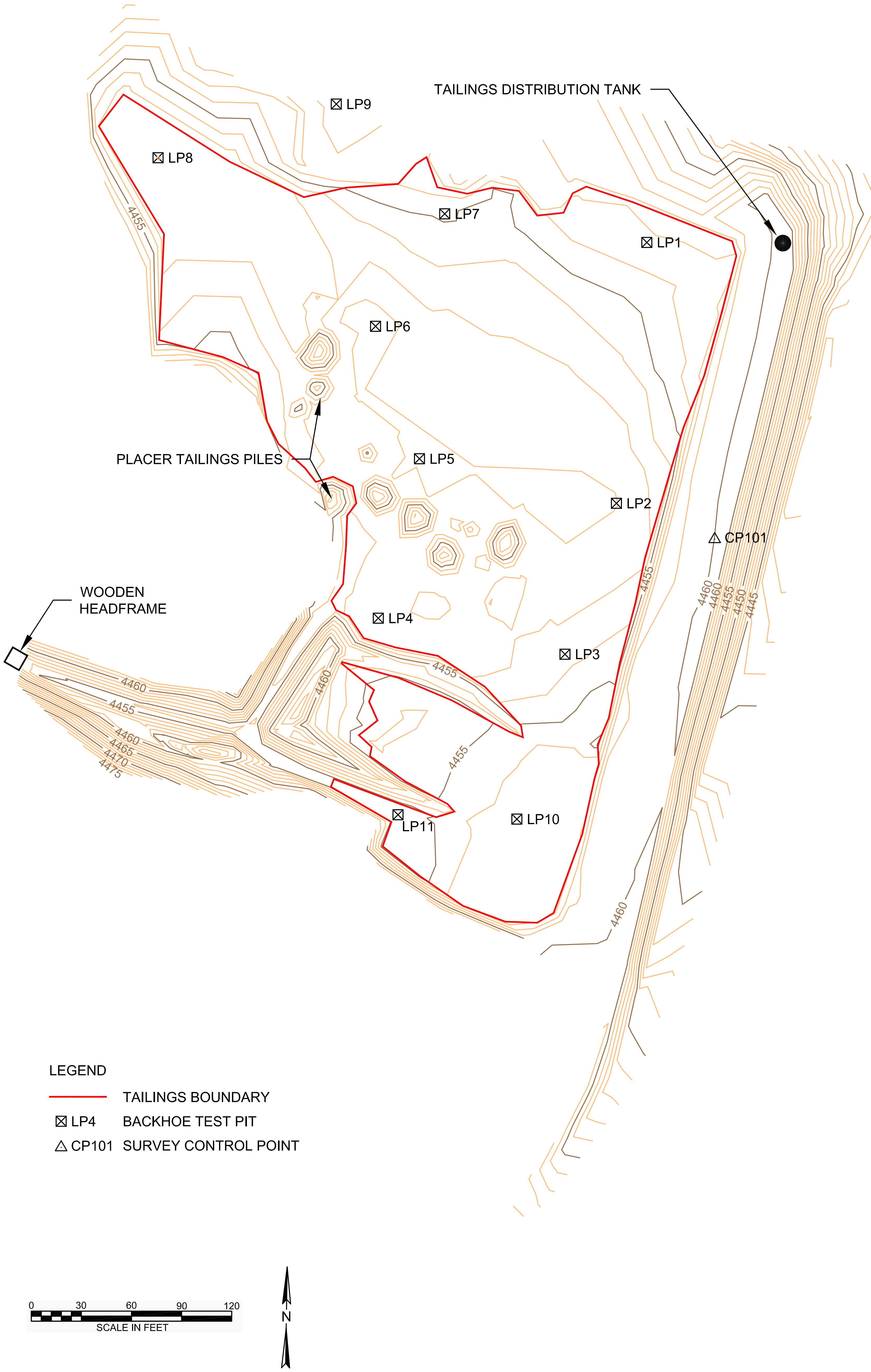
The mean concentrations from the laboratory quantitative analyses on representative composite samples generally corroborate the XRF screening mean concentration results with the exception of Cd and Hg. Cadmium was not detected and the mean concentration for Hg is significantly higher via XRF method. The analytes with an average concentration greater than or equal to three times the average background soil concentration include: Cd, Cu, Hg, Pb and Zn. Although total cyanide was not compared to average background soil because the parameter was not analyzed in these soils, the tailings mean concentration of 0.8 mg/Kg and a maximum concentration of 1.0 mg/Kg are slightly elevated.

The XRF and laboratory data for native soils collected below the tailings indicate that As and Hg concentrations are present near the contact zone with tailings. Although As concentrations are commensurate with the tailings, they are considered low soil concentrations at generally less than 100 mg/Kg. Although mercury was detected in half of the XRF samples, it was considered no detection based upon the analytical instrument data validation method. Mercury was, however, detected in the single composite sample collected for quantitative laboratory analysis from test pits UP1, UP2, UP4 and UP7. Although the concentration of 25 mg/Kg is lower than the mean concentration of the Upper Pond Area tailings, it is significantly elevated in the native soils. The mercury could be related to placer tailings which are widespread in this area of the Silver Creek drainage. Although mercury concentrations in placer tailings can be highly variable, mercury was detected in most of the placer tailings sampled during the Phase I reconnaissance work (DEQ-MWCB/Olympus, 2003a). The native soil composite sample base metal concentrations for Cu, Pb and Zn are generally low and total cyanide was not detected.

#### 3.2.1.4 Lower Pond Area Tailings Volume, Geology and Chemistry

The Lower Pond Area tailings pile is located in the NE¼ Section 3, Township 11 North and Range 5 West, Montana Principal Meridian (Figure 1-1). The Lower Pond Area tailings were probably generated from the Goldsil mill operations in the 1970's. A tailings dam is constructed along the eastern boundary and is tied into placer tailings berms to form an impoundment into which the tailings were deposited. Placer tailings piles, comprised of rock with very little fine grained sediment, form conspicuous islands within the tailings impoundment. These islands suggest that the Lower Pond Area tailings are deposited upon placer tailings verses native soils. The tailings dam is constructed of native materials which appear to have been excavated from an open cut immediately to the southwest of the tailings pond. Although there are areas barren of vegetation, the tailings are generally moderately well vegetated with grasses, sagebrush, some willows and weeds.

The location of the Lower Pond Area tailings is superimposed on an aerial photograph and is shown on Figure 3-8. A detailed survey of the Lower Pond tailings area was completed and the topographic map is shown on Figure 3-10. The tailings volume was estimated using the detailed topographic survey of the tailings surface and the test pit data. The volume estimate method is detailed in the Silver Creek Drainage Project Phase II Site Characterization Report (DEQ-MWCB/Olympus, 2003b). The estimated volume of the tailings is 20,710 cubic yards including an area of placer tailings piles that are mostly covered with tailings. Only the tops of the placer tailings piles are visible and form small "islands" within the mill tailings deposits. The volume of placer tailings piles within the Lower Pond tailings are estimated at 3,040 cubic yards. The tailings volume excluding the placer tailings piles is 17,670 cubic yards. The tailings plan area is 1.77 acres, excluding the placer pile area, and the average tailings depth is 6.20 feet. The maximum tailings thickness measured in the test pits was 14.0 feet. A total of 11 test pits were excavated in the Lower Pond tailings.

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LOWER POND AREA

FIGURE 3-10

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The tailings contained in the Lower Pond Area consist predominantly of beige to light tan silts and fine grained sands with lesser brown and gray clays. The fine grained silt and sand tailings exhibit a floury texture. Iron oxide is variable and most commonly associated with the more clay-rich lenses, as is increased moisture content. The native materials beneath the tailings are variable and consist of rock-rich placer tailings and/or brown sand and gravel with rock.

The principal discharge point for tailings into the Lower Pond Area appears to have been near the northeastern corner of the tailings dam. There is a steel distribution tank and associated PVC piping which were used to discharge tailings into the pond from the main tailings line. Field evidence of sections of metal-banded wooden pipe partially filled with tailings suggest that the main tailings line most likely ran along the northern boundary of the Lower Pond Area (Figure 3-8).

Representative samples were collected from vertical channel samples taken from test pit walls or from grab samples collected from the test pit excavation stockpiles. Individual samples were collected based on similar geologic characteristics. Nineteen tailings samples and two representative composite tailings samples were collected from the Lower Pond Area tailings for qualitative to semi-quantitative XRF screening. The Lower Pond Area tailings XRF range and mean concentration results for the principal elements of interest are as follows: Ag (34.2-54 ppm and 44.3 ppm), As (18-68 ppm and 37.2 ppm ), Ba (no detection), Cd (no detection), Cr (no detection), Cu (35-172 ppm and 74.3 ppm), Fe (3,630-13,090 ppm and 6,796.7 ppm), Hg (73-328 ppm and 150.6 ppm), Mn (150-600 ppm and 357.9 ppm), Ni (52-335 ppm and 149.3 ppm), Pb (88.2-136 ppm and 108.5 ppm), Sb (500-1,049 ppm and 628.4 ppm), and Zn (113-516 ppm and 280.0 ppm).

Laboratory analytical data for the two composite samples collected from the Lower Pond Area tailings are summarized in Table 3-4. A limited laboratory analytical suite consisting of pH, As, Cd, Cu, Hg, Pb, Zn and total cyanide was used for the Lower Pond Area tailings. These tailings were identified during the Phase I reconnaissance work in the Silver Creek Drainage Project and were analyzed according to the Phase I work analytical protocol. The tailings pH is alkaline ranging from 8.0 to 8.1 standard units (SU). The following are the mean concentration and enrichment relative to the background mean concentrations for each element.

**Lower Pond Area Mean Tailings Element Concentrations Compared to Background**
(quantitative laboratory results)

All Results in mg/kg

| As | Cd | Cu | Hg | Pb | Zn | T CN |
|---|---|---|---|---|---|---|
| 28.0 | 2.0 | 125.0 | 32.0 | 119.5 | 255.5 | 3.5 |
| *1.3x* | *>4.0x* | *3.7x* | *>64x* | *10.6x* | *3.7x* | *a* |

*a - Analyte total cyanide was not analyzed in background soils*
*Hg and Cd were not detected in background soils above detection limit*

The mean concentrations from the laboratory quantitative analyses on representative composite samples generally corroborate the XRF screening mean concentration results with the exception of Cd and Hg. Cadmium was not detected and the mean concentration for Hg is significantly higher via XRF method. The analytes with an average concentration greater than or equal to three times the average background soil concentration include: Cd, Cu, Hg, Pb and Zn. Although total cyanide was not compared to average background soil because the parameter was not analyzed in these soils, the tailings mean concentration of 3.5 mg/Kg and a maximum concentration of 5.0 mg/Kg are moderately elevated.

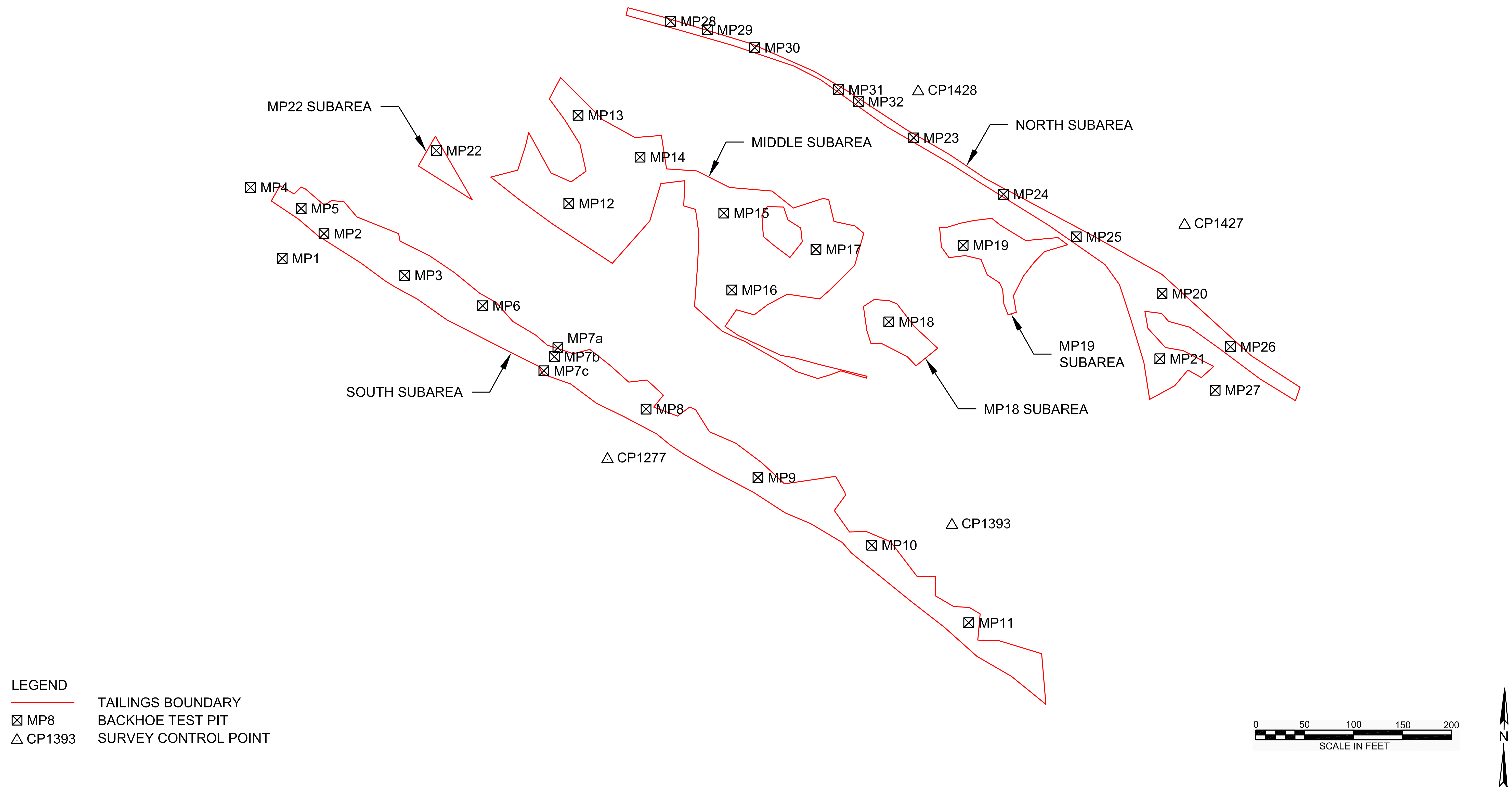
#### 3.2.1.5 Middle Pond Area Tailings Volume, Geology and Chemistry

The Middle Pond Area tailings pile is located in the SE¼ Section 34, Township 12 North and Range 5 West and NE¼ Section 3, Township 11 North and Range 5 West, Montana Principal Meridian (Figure 1-1). Some of the Middle Pond Area tailings were probably generated from the Goldsil mill operations in the 1970's. The tailings were deposited within an area of placer tailings and seem to have been deposited in topographic low areas within the placer tailings piles. There is field evidence that indicates the placer piles have been disturbed. In some areas the placer tailings have been dozed into berms, while in other areas they have been graded out. The berm configurations suggest that localized cells may have been created to provide for tailings impoundment. The Middle Pond Area tailings is generally well vegetated except for the processed placer tailings piles that are composed predominantly of rock.

Tailings in the Middle Pond Area were deposited in several areas between existing overburden and processed placer tailings piles (Figure 3-8). The Middle Pond and Lower Pond areas are separated by processed placer tailings piles that have been graded out. Tailings along the northern perimeter of the Middle Pond are associated with spillage from the tailings line between the Upper Pond and Lower Pond dams and are primarily contained in a ditch adjacent to the line. The tailings along the southern perimeter of the Middle Pond area were most likely spilled or discharged starting approximately 200 feet from the southern end of the Upper Pond dam. These tailings were deposited in a narrow, linear configuration between placer tailings piles.

Tailings in the central portion of the Middle Pond are found in pockets between placer tailings piles (Figure 3-8). The origin of deposition of these tailings was not visible in the field. Theories as to how these tailings were deposited include: 1) the tailings were deposited via another discharge line that has been removed, or 2) tailings could have overflowed from the north and south Middle Pond tailings areas in gaps between the hummocky placer piles. The first theory is more likely. A temporary pipe could have been run from the distribution box on the Upper Pond dam to the central portion of the Middle Pond area to discharge the tailings. This could also be how the tailings along the southern Middle Pond perimeter were discharged. The second theory is possible but less likely. It is conceivable that tailings slurry could pond up and flow through gaps in the placer tailings piles, however, direct evidence of this was not observed. A small rock berm was observed near the west end of the southern Middle Pond tailings area. It is possible that a gap in the placer tailings piles could have existed prior to placement of this berm, however, the Middle Pond tailings deposition areas appeared in the field to be completely separated. The Middle Pond tailings were identified in six subareas, consisting of three main and three smaller, isolated deposition zones. The total estimated mill tailings volume for the Middle Pond Area is 11,280 cubic yards which occupy a subarea aggregate of 1.97 acres.

The tailings subareas are shown on Figure 3-11 and are designated as follows: North, Middle, South, MP18, MP19, and MP22. The volume of tailings in the North subarea was estimated from the plan area times the median tailings depth. A total of 11 test pits were excavated in the North subarea. The tailings depth ranged from 0.3 to 6.6 feet, with a median depth of 1.6 feet. The plan area of the North subarea is 0.30 acres and the estimated tailings volume is 780 cubic yards.

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MIDDLE POND TAILINGS AREA

FIGURE 3-11

The volume of tailings in the Middle subarea was estimated from the plan area times the median tailings depth. A total of six test pits were excavated in the Middle subarea. The tailings depth ranged from 1.2 to 4.7 feet, with a median depth of 3.6 feet. The plan area of the Middle subarea is 0.76 acres and the estimated tailings volume is 4,390 cubic yards.

The volume of tailings in the South subarea was estimated from the plan area times the median tailings depth. A total of 11 test pits were excavated in the South subarea. The tailings depth ranged from 1.0 to 7.4 feet, with a median depth of 4.6 feet. The plan area of the Middle subarea is 0.72 acres and the estimated tailings volume is 5,330 cubic yards.

The volume of tailings in the MP18 subarea was estimated from the plan area times the tailings depth. One test pit (MP18) was excavated in the MP18 subarea, with a tailings depth of 2.1 feet. The plan area of the MP18 subarea is 0.052 acres and the estimated tailings volume is 180 cubic yards.

The volume of tailings in the MP19 subarea was estimated from the plan area times the tailings depth. One test pit (MP19) was excavated in the MP19 subarea, with a tailings depth of 1.7 feet. The plan area of the MP19 subarea is 0.11 acres and the estimated tailings volume is 300 cubic yards.

The volume of tailings in the MP22 subarea was estimated from the plan area times the tailings depth. One test pit (MP22) was excavated in the MP22 subarea, with a tailings depth of 3.4 feet. The plan area of the MP22 subarea is 0.024 acres and the estimated tailings volume is 300 cubic yards.

The mill tailings appear to have in-filled around and over placer tailings piles in the Middle Pond Area. The larger placer tailings piles are predominantly rock with little fine-grained sediment. They are generally cone-shaped piles where they have not been disturbed by dozing activities. The mill tailing sediments are located in topographically low areas within the placer tailings. The mill tailings are predominantly characterized as white to light tan, very fine to fine grained silts to sandy silts with variable banding caused by thin layers. These tailings are generally dry and exhibit a floury texture. Lesser tan, silty clays and clayey silts may contain some iron oxide and moisture. The more clayey-rich tailings occur in thin layers within the silt tailings or near the contact with native soil at depth.

Representative samples were collected from vertical channel samples taken from test pit walls or from grab samples collected from the test pit excavation stockpiles. Individual samples were collected based on similar geologic characteristics. Fourteen tailings samples and four representative composite tailings samples were collected from the Middle Pond Area tailings for qualitative to semi-quantitative XRF screening. In addition, three native soil samples and one composite native soil were collected for XRF screening.

The Middle Pond Area tailings XRF range and mean concentration results for the principal elements of interest are as follows: Ag (no detection), As (20-88 ppm and 40.8 ppm ), Ba (442-863 and 584.4 ppm), Cd (no detection), Cr (no detection), Cu (no detection), Fe (4,080-12,900 ppm and 5,968.3 ppm), Hg (22-93 ppm and 46.1 ppm), Mn (no detection), Ni (47-254 ppm and 116.1 ppm), Pb (33-121 ppm and 83.1 ppm), Sb (55-86 ppm and 55 ppm), and Zn (74-314 ppm and 201.7 ppm).

Laboratory analytical data for the two tailings and one native soil composite samples collected from the Middle Pond Area tailings are summarized in Table 3-4. A limited laboratory analytical suite consisting of pH, As, Cd, Cu, Hg, Pb, Zn and total cyanide was used for the Middle Pond Area tailings. These tailings were identified during the Phase I reconnaissance work in the Silver Creek Drainage Project and were analyzed according to the Phase I work analytical protocol. The tailings pH is alkaline ranging from 7.4 to 7.7 standard units (SU). The following are the mean concentration and enrichment relative to the background mean concentrations for each element.

**Middle Pond Area Mean Tailings Element Concentrations Compared to Background**
(quantitative laboratory results)

All Results in mg/kg

| As | Cd | Cu | Hg | Pb | Zn | T CN |
|---|---|---|---|---|---|---|
| 23.5 | 1.9 | 103.8 | 18.8 | 110.8 | 217.3 | 9.7 |
| *1.1x* | *>3.8x* | *3.0x* | *>37.6x* | *9.8x* | *3.2x* | *a* |

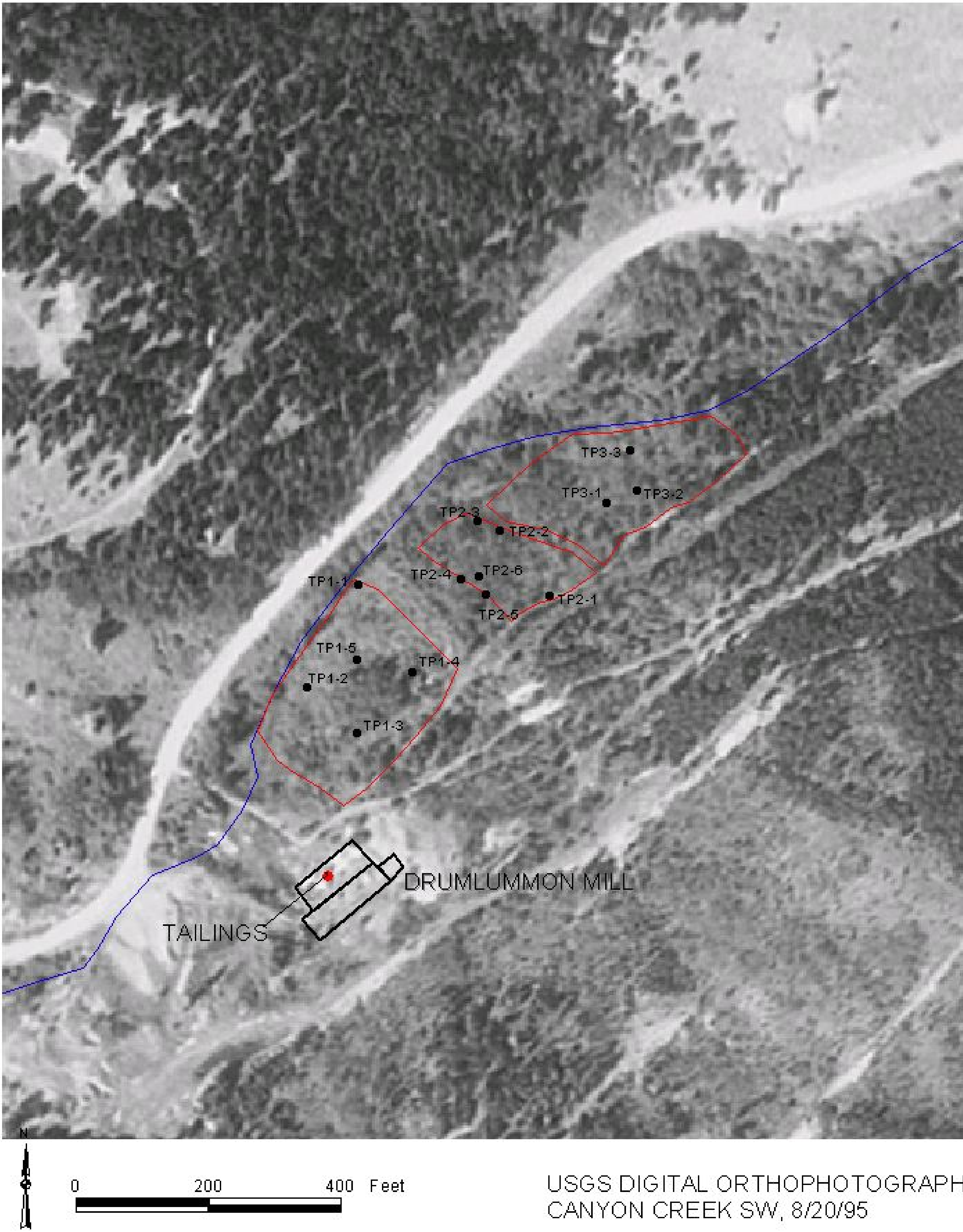
*a - Analyte total cyanide was not analyzed in background soils*
*Hg and Cd were not detected in background soils above detection limit*

The mean concentrations from the laboratory quantitative analyses on representative composite samples generally corroborate the XRF screening mean concentration results with the exception of Cd, Cu and Hg. Cadmium and Cu were not detected and the mean concentration for Hg is significantly higher via XRF method. The analytes with an average concentration greater than or equal to three times the average background soil concentration include: Cd, Cu, Hg, Pb and Zn. Although total cyanide was not compared to average background soil because the parameter was not analyzed in these soils, the tailings mean concentration of 9.7 mg/Kg and a maximum concentration of 23.9 mg/Kg are significantly elevated.

The XRF and laboratory data for native soils collected below the tailings indicate that arsenic concentrations are present near the contact zone with tailings. Although arsenic concentrations are slightly elevated relative to the tailings, they are considered low soil concentrations at less than 100 mg/Kg. Mercury was not detected in the composite native soil sample collected from test pits MP3, MP6 and MP9. The base metals Cu, Pb and Zn are all near background soil concentrations for these elements. Total cyanide was detected in the native soil composite at 2.1 mg/Kg. Although this concentration is below the tailings mean concentration, it is elevated and suggests some movement of cyanide into the native soil contact zone.

#### 3.2.1.6 Drumlummon Millsite Tailings Volume, Geology and Chemistry

The Drumlummon millsite tailings piles (TP1, TP2 and TP3) are located in the SE¼ Section 36, Township 12 North and Range 6 West, Montana Principal Meridian (Figure 1-1). The aerial photograph presented in Figure 3-12 shows the location of the tailings piles and test pits used to evaluate the Drumlummon millsite tailings. The tailings piles are located within 900 feet downstream along the Silver Creek drainage from the Drumlummon mill foundation. A berm diverts Silver Creek to the north of the three tailings piles along Marysville Road. Tailings pile TP1, which is the farthest upstream, is formed by a dam across the drainage bottom. The dam has a 10-inch steel pipe through it to provide overflow drainage. The dam is approximately 15 feet high on the downstream side, and there is approximately 8 feet of freeboard on the upstream side. The tailings in the pond are well vegetated with grass and willows.




USGS DIGITAL ORTHOPHOTOGRAPH:
CANYON CREEK SW, 8/20/95

Legend
- Test Pit
- Tailings Boundary
- Silver Creek

**Olympus Technical Services, Inc.**

Figure 3-12. Drumlummon Millsite Tailings Piles TP-1, TP-2 and TP-3

Tailings pile TP-2 is located immediately downstream from TP-1. Silver Creek flows to the north and is separated from TP-2 by a berm. Similar to TP-1, the pond is formed by a dam constructed across the drainage bottom. TP-2 is mostly covered with trees, brush and grasses, but has occasional bare spots where tailings are visible. The TP-2 dam is approximately 6 to 8 feet high.

Located immediately downstream of TP-2 is tailings pile TP-3. Silver Creek is still diverted to the north of TP-3. The creek returns to the bottom of the drainage below TP-3. The tailings pile is somewhat irregular in shape, formed by several small berms and was apparently deposited over placer tailings piles. Because of deposition over placer tailings, it has an irregular thickness. The tailings are covered with trees and brush, similar to TP-2.

The tailings pile volumes were estimated by using the plan area and median tailings depth. The tailings piles were delineated in the field by GPS coordinates and plotted on scaled USGS digital orthophotograph quadrangles (DOQs). The plan area was scaled from the DOQs in AutoCAD. The depth of tailings was measured in shovel pits and hand auger borings advanced through tailings.

The volume of tailings pile TP1 (Figure 3-12) was estimated from the plan area times the median tailings depth determined from five shovel pits/hand auger borings. The tailings depth ranged from 1.0 to 4.4 feet with a median depth of 2.3 feet. The plan area of the tailings is 1.22 acres and the estimated tailings volume is 4,530 cubic yards.

The volume of tailings pile TP2 (Figure 3-12) was estimated from the plan area times the median tailings depth determined from six shovel pits/hand auger borings. The tailings depth ranged from 0 to 3.8 feet with a median depth of 1.77 feet. The plan area of the tailings is 0.54 acres and the estimated tailings volume is 1,540 cubic yards.

The volume of tailings pile TP3 (Figure 3-12) was estimated from the plan area times the average tailings depth determined from three shovel pits/hand auger borings. The tailings depth ranged from 2.5 to 3.0 feet with an average depth of 2.67 feet. The plan area of the tailings is 1.04 acres and the estimated tailings volume is 4,450 cubic yards. Tailings pile TP3 appeared to be deposited over old placer tailings piles. Because of the presence of the placer piles, the tailings depth is expected to be highly variable, which could significantly affect the volume estimate. Therefore, the volume of 4,450 cubic yards is probably conservatively high.

A small volume of tailings is present within the Drumlummon mill foundation. The tailings are present on the main vat level of the foundation and are visually estimated to be less than 50 cubic yards. The character of the support foundations in this area suggest that vat leach tanks were probably located at this level in the mill and the tailings may be residual spillage during mill operations. The composite sample chemistry results for this tailings would support the vat leach interpretation for the data indicate elevated total cyanide concentration (24.8 mg/Kg) in the tailings. The tailings consist of white to tan silty sand containing variable yellow brown to red brown FeOx.

The Drumlummon millsite tailings piles TP1, TP2 and TP3 consist of predominantly light tan to light brown silty sand to sand. Lesser types include clayey sand, sandy clay and clay. Some red-orange to reddish brown oxidation is evident generally as streaks within the tailings. The native soils beneath the tailings piles are composed of brown sandy loam and rock. In the area of tailings pile TP3, the tailings appear to be deposited upon placer tailings.

Representative tailings samples were collected from shovel and/or hand auger borings. The number of samples collected were limited because of the small volume of these tailings relative to the other tailings areas. Individual samples were collected based on similar geologic characteristics. Five composite tailings samples were collected from the Drumlummon millsite tailings piles for XRF screening and laboratory analysis. The Drumlummon millsite tailings XRF range and mean concentration results for the principal elements of interest are as follows: Ag (no detection), As (27-38 ppm and 33.7 ppm ), Ba (842-1,056 ppm and 954 ppm), Cd (no detection), Cr (no detection), Cu (no detection), Fe (5,470-9,990 ppm and 7,266 ppm), Hg (no detection), Mn (230-340 ppm and 288 ppm), Ni (70-195 ppm and 122 ppm), Pb (26-175 ppm and 70.6 ppm), Sb (24-102 ppm and 60 ppm), and Zn (51-274 ppm and 133 ppm).

The laboratory data are summarized in Table 3-4. The Drumlummon millsite tailings pH is alkaline ranging from 7.3 to 8.2 standard units (SU). The following are the mean concentration and enrichment relative to the background mean concentrations for each element.

**Drumlummon Millsite Mean Tailings Element Concentrations Compared to Background**
(quantitative laboratory results)

All Results in mg/kg

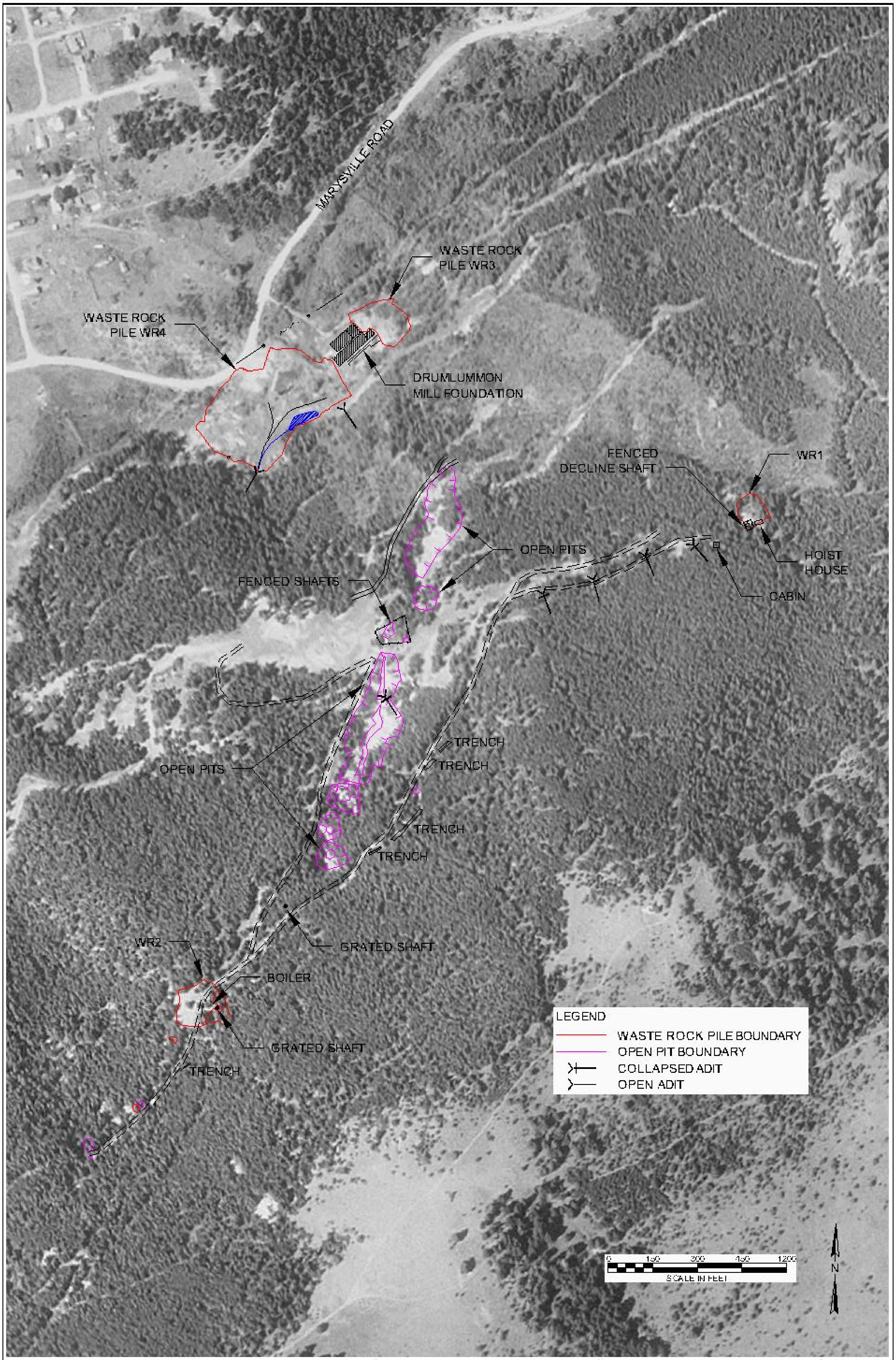
| As | Cd | Cu | Hg | Pb | Zn | T CN |
|---|---|---|---|---|---|---|
| 28.0 | a | 97.6 | 4.1 | 117.2 | 181 | 5.7 |
| *1.3x* | | *2.9x* | *>8.2x* | *10.4x* | *2.6* | *b* |

*a - Analyte Cd was not detected in the tailings*
*b - Analyte total cyanide was not analyzed in background soils*
*Hg was not detected above detection limit in background soils*

Analyte concentrations where only a single analysis was performed include: Ag 8 mg/Kg, Ba 88 mg/Kg, Cr 11 mg/Kg, Fe 10,600 mg/Kg, Mn 474 mg/Kg, Ni <5 mg/Kg, and Sb 10 mg/Kg. The analytes with an average concentration greater than or equal to three times the average background soil concentration include: Hg and Pb. Although total cyanide was not compared to average background soil because the parameter was not analyzed in these soils, the tailings mean concentration of 5.7 mg/Kg and a maximum concentration of 24.8 mg/Kg is elevated. With the exception of Ag and Sb, all of the single sample element concentrations were below the mean concentration for background soil, and only the Ag concentration exceeded three times the average background soil concentration.

### 3.2.2 Drumlummon Mine/Millsite Waste Rock Piles Volume Estimate, Geology and Chemistry

The Drumlummon millsite and mine are located in Section 36, Township 11 and 12 North, Range 6 West, Montana Principal Meridian (Figure 1-1). The aerial photograph presented in Figure 3-13 provides more detail on the millsite and mine areas. The millsite and mine occur in steep mountainous terrain that is predominantly forested. A site investigation was made of the Drumlummon millsite and mine to characterize the waste sources and identify any physical hazards that may be present.

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|---|---|---|---|---|---|---|---|---|
| Olympus Technical Services, Inc. | | | | MONTANA DEQ/MINE WASTE CLEANUP BUREAU<br>SILVER CREEK DRAINAGE PROJECT<br>LEWIS & CLARK COUNTY, MONTANA | | | AERIAL PHOTOGRAPH OF THE<br>DRUMLUMMON MINE<br>AND MILLSITE AREAS | FIGURE<br>3-13 |
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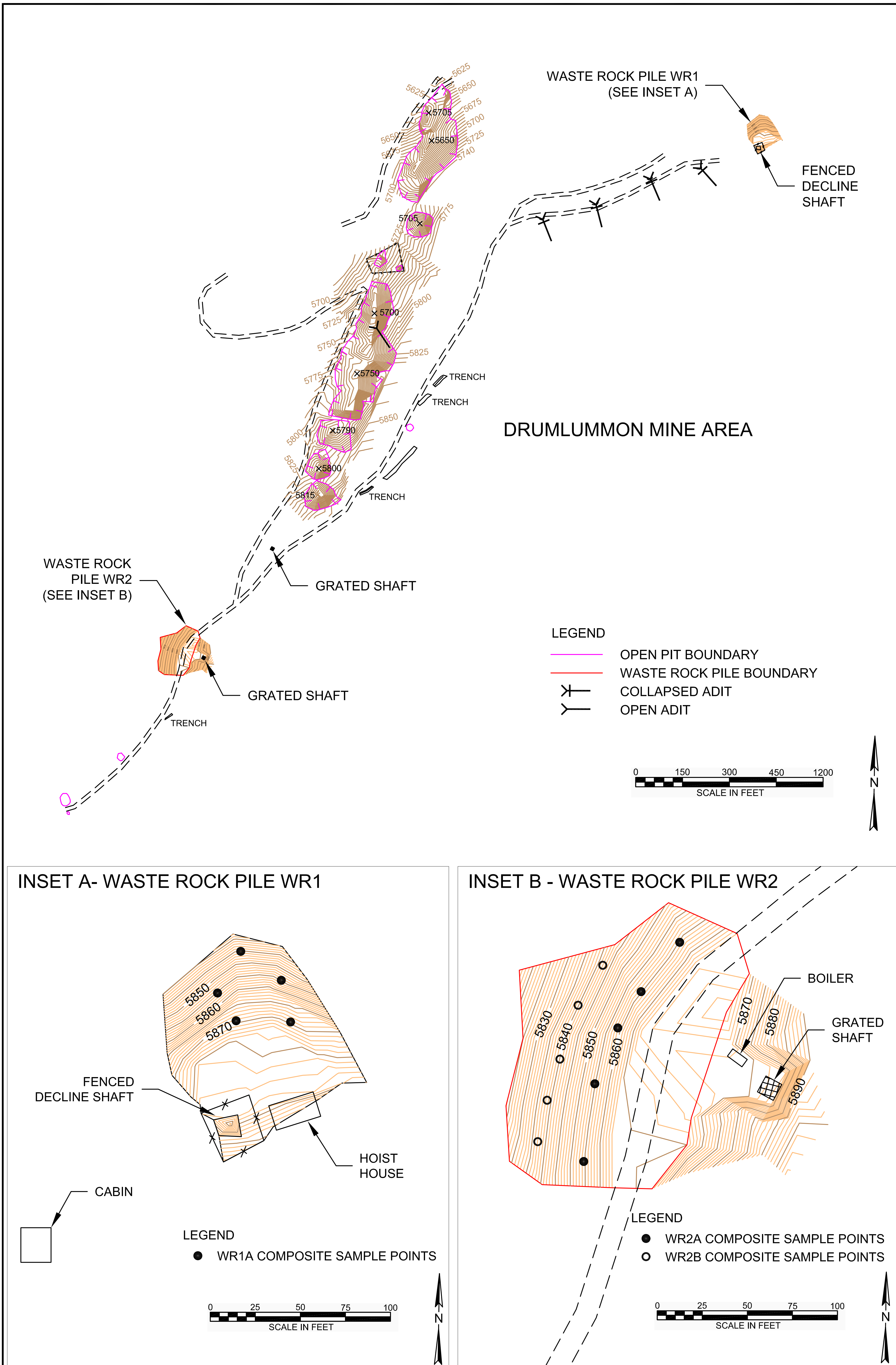
Four waste rock piles (WR1 through WR4) were identified at the Drumlummon millsite and mine. Waste rock piles WR1 and WR2 are small piles associated with upper mine area, while the two largest piles, WR3 and WR4 occur in close proximity to the millsite. The latter piles appear to be underground development waste rock that most likely was trammed out from the main haulage level adit. The portal for this adit is located near the south boundary of waste rock pile WR4. The millsite and mine area waste rock piles were surveyed as part of the site topographic map surveys. These survey data were used to calculate volume estimates for the waste rock piles. The volume estimate method is detailed in the Phase II Site Characterization Report for the Silver Creek Drainage Project (DEQ-MWCB/Olympus, 2003b).

Waste rock pile WR1 is located near the east end of the Drumlummon mine area (Figure 3-13). A detailed topographic survey of WR1 was completed (Figure 3-14) and used to estimate the waste rock volume. No test pits were excavated in the waste rock pile because of the coarseness of the material and the steep slope of the face. Therefore, the native surface below the pile was estimated by projecting from the hill slopes adjacent to the waste rock pile. The estimated volume of WR1 is 1,460 cubic yards. The plan area of WR1 is 0.19 acres and the average waste rock depth is 4.71 feet.

Waste rock pile WR2 is located near the west end of the Drumlummon mine area (Figure 3-13). A detailed topographic survey of WR2 was completed and used to estimate the waste rock volume (Figure 3-14). No test pits were excavated in the waste rock pile because of the coarseness of the material and the steep slope of the face. Therefore, the native surface below the pile was estimated by projecting from the hill slopes adjacent to the waste rock pile. The estimated volume of WR2 is 2,960 cubic yards. The plan area of WR2 is 0.34 acres and the average waste rock depth is 5.37 feet.

Waste rock pile WR3 is located at the east end of the Drumlummon mill (Figure 3-13). The pile appears to consist of an older portion in the lower half and a newer portion that was end dumped over the lower half. A detailed topographic survey of WR3 was completed and used to estimate the waste rock volume (Figure 3-15). No test pits were excavated in the waste rock pile because of the coarseness of the material and the steep slope of the face. Therefore, the native surface below the pile was estimated by projecting from the hill slopes adjacent to the waste rock pile. The estimated volume of WR3 is 3,500 cubic yards. The plan area of WR3 is 0.45 acres and the average waste rock depth is 4.84 feet.

Waste rock pile WR4 is located at the west end of the Drumlummon mill and extends northward to Marysville Road (Figure 3-13). The waste rock appears to have originated from a main haulage adit at the south end of the pile. Rail tracks are present on the top of WR4 and extend from the adit to the north end of WR4 with a spur that runs northeast toward the mill. The tracks probably extended behind the mill to waste rock pile WR3. A detailed topographic survey of WR4 was completed and used to estimate the waste rock volume (Figure 3-15). No test pits were excavated in the waste rock pile because of the coarseness of the material and the steep slope of the face. Therefore, the native surface below the pile was estimated by projecting from the existing elevations below the toe of the pile and from the slopes adjacent to the waste rock pile. The estimated volume of WR4 is 110,510 cubic yards. The plan area of WR4 is 2.77 acres and the average waste rock depth is 24.75 feet. The maximum waste rock depth is approximately 74 feet.

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DRUMLUMMON MINE AREA

FIGURE 3-14

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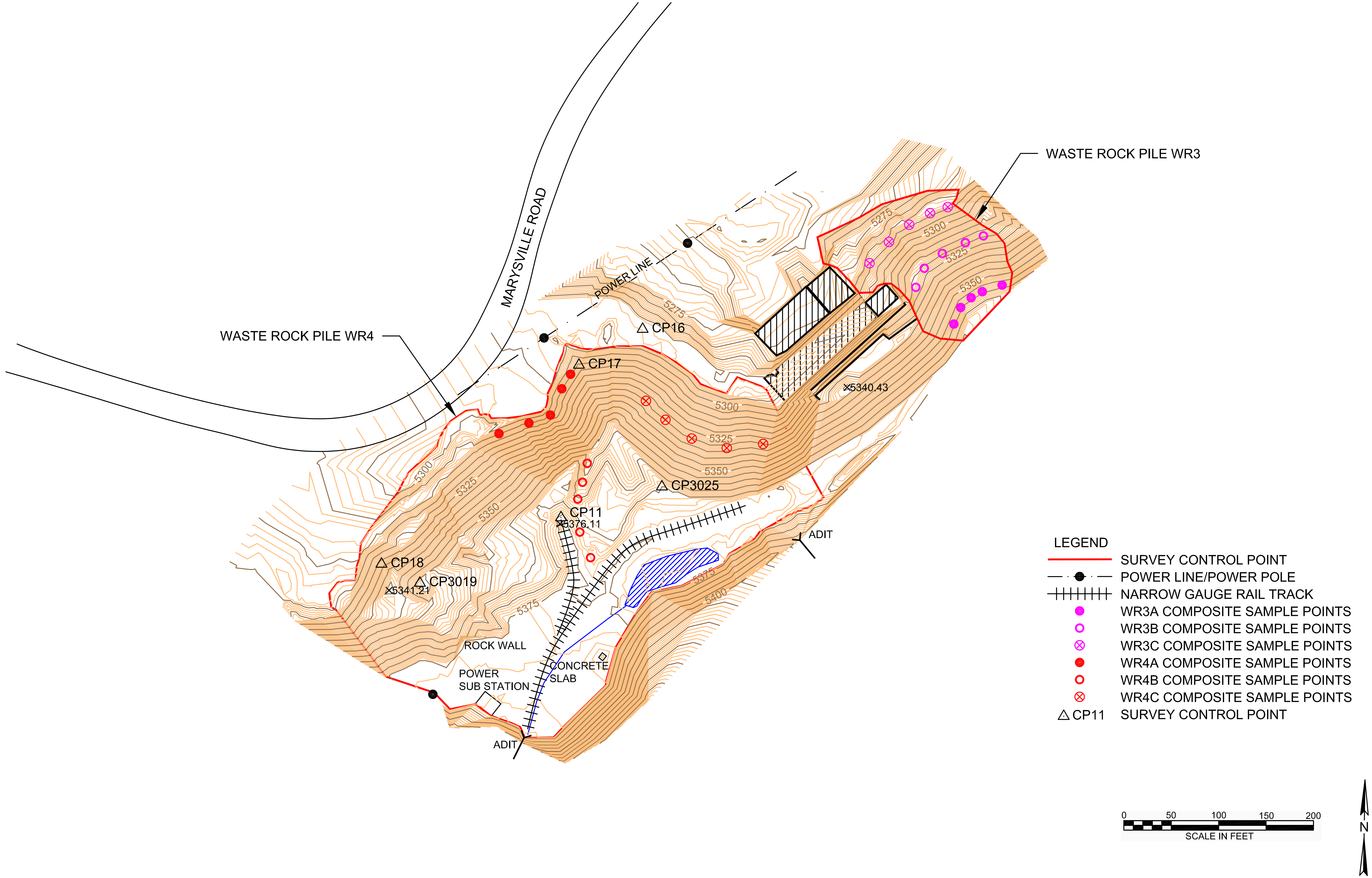


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|---|---|---|---|---|---|---|---|---|---|
| | | | | DESIGN: | DRAWN: KSR | CHECKED: CRS | MONTANA DEQ/MINE WASTE CLEANUP BUREAU<br>SILVER CREEK DRAINAGE PROJECT<br>LEWIS & CLARK COUNTY, MONTANA | Olympus Technical Services, Inc. | DRUMLUMMON MILLSITE AREA<br>WASTE ROCK PILES WR3 AND WR4<br>EXISTING TOPOGRAPHY | FIGURE<br>3-15 |
| | | | | APPROVED: | DATE: 4/2003 | JOB NO: A1348 | | | | |
| NO. | REVISION DESCRIPTION | BY | DATE | SCALE: AS SHOWN | FILENAME: A1348Dmill.dwg | | | | | |

The Drumlummon waste rock piles are generally steep angle of repose piles, the larger of which were likely generated from side dumping rail cars used for underground mine haulage. The Drumlummon waste rock piles gradation consists of a heterogeneous mixture of sand to ≥ 12-inch diameter rock. Rock is the predominant component of the waste rock piles and consists of black to greenish, fine-grained hornfels with various degrees of propylitic alteration, granodiorite to quartz diorite, and a trace of limestone to dolomite. Lesser white quartz and/or carbonate vein and brecciated hornfels material with some sulfide may be present. Iron oxide occurring as orange brown to red brown coloration is variable at WR4 and WR3, but generally not abundant in the waste rock piles. It is most noticeable in the lower section of the toe area of waste rock pile WR4. This pile has recent evidence of excavation, suggesting that it is being used as a borrow source. Excavation has also exposed thin layers (generally ≤ 6-inch thick) of charcoal in WR4. The source of this charcoal was probably furnace charcoal generated during mill operations. Waste rock piles WR1 and WR2 did not show any noteworthy evidence of FeOx alteration.

The main haulage level adit, located near the south end of the WR4 waste rock pile is discharging water. The water drains to a small pond located on top of the WR4 (Figure 3-15) where it evaporates and infiltrates into the pile. The flow of water at the time of this site characterization was low, probably less than 1 gallon per minute (gpm). Discharge flow estimates of up to 45 gpm have been made for this adit during earlier site characterization studies. No evidence for ponding of water was observed on the other waste rock piles.

Representative samples were collected from shovel pits excavated into the waste rock piles. Individual samples were collected based on similar geologic characteristics. Nine waste rock pile samples and two representative composite waste rock samples were collected from the Drumlummon millsite and mine areas for XRF screening. The Drumlummon millsite and mine waste rock XRF range and mean concentration results for the principal elements of interest are as follows: Ag (no detection), As (43-80 ppm and 64.3 ppm ), Ba (715-1,876 ppm and 1,210.5 ppm), Cd (no detection), Cr (no detection), Cu (no detection), Fe (14,990-27,730 ppm and 18,761.8 ppm), Hg (no detection), Mn (190-1,130 ppm and 547.3 ppm), Ni (262-747 ppm and 424.5 ppm), Pb (15-338 ppm and 109.6 ppm), Sb (50-120 ppm and 80.8 ppm), and Zn (45-273 ppm and 105.1 ppm). The Drumlummon waste rock XRF results indicate that the waste rock generally contains undetectable to low concentrations for the principal elements of interest, i.e. Ag, As, Cd, Cu, Hg, Mn, Pb, and Zn.

Laboratory analytical data for the two composite samples collected from the Drumlummon waste rock piles are summarized in Table 3-5. The waste rock pH is alkaline ranging from 8.1 to 8.6 standard units (SU). The following are the mean concentration and enrichment relative to the background mean concentrations for each element.

**Drumlummon Mean Waste Rock Element Concentrations Compared to Background**
(quantitative laboratory results)

All Results in mg/kg

| Ag | As | Ba | Cd | Cr | Cu | Fe | Hg | Mn | Ni | Pb | Sb | Zn | T CN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3.8 | 17.0 | 79.5 | a | 12.0 | 52.5 | 13,550 | 1.3 | 429.0 | 8.5 | 39.5 | 4.3 | 66.0 | b |
| *1.5x* | *0.8x* | *0.6x* | | *1.0x* | *1.5x* | *1.0x* | *>2.6x* | *0.9x* | *0.9x* | *3.5x* | 0.9x | *1.0x* | |

*a - Analyte Cd was not detected in waste rock samples*
*b - Analyte total cyanide was not analyzed in waste rock samples*

Table 3-5. Laboratory Chemistry Results for Waste Rock

| Sample ID | pH (SU) | Ag (mg/Kg) | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Pb (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 25-024-WR5 | 8.6 | <5 | 7 | 52 | <1 | 14 | 53 | 15000 | 12 | <1 | 442 | 8 | <5 | 46 |
| 25-024-WR6 | 8.1 | 5 | 27 | 107 | <1 | 10 | 52 | 12100 | 67 | 2 | 416 | 9 | 6 | 86 |
| **Maximum** | 8.6 | 5 | 27 | 107 | | 14 | 53 | 15000 | 67 | 2 | 442 | 9 | 6 | 86 |
| **Minimum** | 8.1 | <5 | 7 | 52 | | 10 | 52 | 12100 | 12 | <1 | 416 | 8 | <5 | 46 |
| **Mean** | 8.4 | 3.8 | 17.0 | 79.5 | | 12.0 | 52.5 | 13550.0 | 39.5 | 1.3 | 429.0 | 8.5 | 4.3 | 66.0 |
| **n** | 2 | 2 | 2 | 2 | | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |

**LEGEND**

25-024-WR5 is a composite of 25-SCD-WR1, WR2A & WR2B
25-024-WR6 is a composite of 25-SCD-WR3A, WR3B, WR3C, WR4A, WR4B & WR4C

Note: Statistics - one half the lower detection limit is used where below detection limit samples are included in the mean calculation

The mean concentrations from the laboratory quantitative analyses on representative composite samples generally corroborate the low concentrations determined by XRF screening. The data suggest that most of the waste rock was probably derived from non-mineralized country rock which was removed from the underground mine during mine development. The low concentration of Hg detected in one of the composite samples is most likely natural occurring and is related to the precious metal vein system that constitutes the orebody in the mine. The only analyte with an average concentration greater than or equal to three times the average background soil concentration is Pb.

### 3.2.3 Summary of Mill Tailings and Waste Rock Chemistry Results

The results discussed in the preceding sections indicate that one or more elements are present in the mill tailings at average concentrations greater than three times the background soil concentration. These elements, identified as the primary elements of concern for the mill tailings, include Ag, Cd, Cu, Hg, Pb, and Zn. The average concentration for Sb exceeded three times the background soil concentration only in the Goldsil tailings. Although total cyanide was not analyzed in background samples, total cyanide was generally elevated in most of the mill tailings except the Drumlummon tailings pile. Lead was the only element in the waste rock at an average concentration greater than three times the background soil concentration.

### 3.2.4 Mill Tailings and Waste Rock Acid/Base Accounting Results

The mill tailings in the Silver Creek Drainage area generally do not show much field evidence of acid rock drainage (ARD) problems. The following observations support the non-acid generating character of the mill tailings:

- Tailings are generally moderately to well vegetated with a variety of plants and trees.
- Iron oxide is generally minor in most of the tailings with the exception of the Drumlummon tailings.
- Silver Creek, which either flows through or is in close proximity to the major mill tailing areas, does not exhibit ARD characteristics, i.e. low pH water, strong iron oxide staining of stream gravel/rock, and elevated metals in surface water.
- Paste pH data indicate that the mill tailings are alkaline.

Composite samples of mill tailings from the Goldsil tailings and the Drumlummon tailings were evaluated for static ABA methods to evaluate the acid generating potential and inherent neutralization capability of the tailings. The Goldsil tailings and the Drumlummon tailings represent the major sources of mill tailings in the Silver Creek Drainage Project area. A total of eleven composite samples were collected for ABA analyses at Energy Laboratories, Inc. The laboratory analytical results are summarized in Table 3-6. The ABA data indicate that the total sulfur concentrations in the mill tailings are low ranging from 0.03% to 0.06%. Low total sulfur concentrations limit the potential for ARD development. All of the composite samples show significant positive net ABA ranging from 64 to 109, indicating that the mill tailings are probably not acid generating. The inherent neutralization potential of the mill tailings is further corroborated by the XRF results for calcium that showed concentrations in the Goldsil tailings and Drumlummon tailings ranging from 0.8% to 3.7%. These data indicate that calcium carbonate ($CaCO_3$) concentrations may be as high as 9.2% in the tailings.

**Table 3-6. Acid-Base Accounting Results For Mill Tailings and Waste Rock**

| Sample ID | Total Sulfur (%) | Pyritic Sulfur (%) $HNO_3$ Ext. S | Sulfate Sulfur (%) HCL Ext. S | Hot $H_2O$ Ext. S (%) | Residual Sulfur (%) | Non-SO4 S (%)** | Calc AGP | Acid Gen Potential * | Neutraliz Potential * | Acid/Base Potential * |
|---|---|---|---|---|---|---|---|---|---|---|
| 25-365-TP-12 | 0.06 | 0.03 | <0.01 | 0.03 | 0.01 | 0.03 | 0.94 | 1 | 110 | 109 |
| 25-365-TP-13 | 0.06 | 0.04 | <0.01 | 0.02 | 0.01 | 0.04 | 1.25 | 1 | 91 | 90 |
| 25-365-TP-14 | 0.06 | 0.03 | 0.01 | 0.01 | 0.01 | 0.05 | 1.56 | 2 | 100 | 98 |
| 25-365-TP-15 | 0.05 | 0.03 | <0.01 | 0.01 | 0.01 | 0.04 | 1.25 | 1 | 78 | 77 |
| 25-365-TP-16 | 0.06 | 0.02 | <0.01 | 0.03 | 0.01 | 0.03 | 0.94 | 1 | 80 | 79 |
| 25-365-TP-17 | 0.04 | 0.02 | <0.01 | 0.02 | <0.01 | 0.02 | 0.63 | 1 | 65 | 64 |
| 25-365-TP-18 | 0.04 | 0.02 | <0.01 | 0.01 | 0.01 | 0.03 | 0.94 | 1 | 76 | 75 |
| 25-365-TP-19 | 0.06 | 0.05 | <0.01 | 0.02 | <0.01 | 0.04 | 1.25 | 1 | 92 | 91 |
| 25-024-TP-1 | 0.06 | 0.02 | <0.01 | 0.02 | 0.02 | 0.04 | 1.25 | 1 | 110 | 109 |
| 25-024-TP-3 | 0.03 | <0.01 | 0.02 | 0.01 | <0.01 | 0.02 | 0.63 | 1 | 100 | 99 |
| 25-024-TP-4 | 0.03 | 0.02 | <0.01 | 0.01 | <0.01 | 0.02 | 0.63 | 1 | 93 | 92 |
| 25-024-WR5 | 0.08 | 0.07 | <0.01 | 0.01 | <0.01 | 0.07 | 2.19 | 2 | 160 | 158 |
| 25-024-WR6 | 0.10 | 0.08 | <0.01 | 0.02 | <0.01 | 0.08 | 2.50 | 3 | 78 | 75 |

* Tons of $CaCO_3$ equivalent per 1000 tons of material (Note: Energy Laboratories, Inc. reports ppt (parts per thousand) which is equivalent)

**Only Hot $H_2O$ extractable sulfur considered sulfate sulfur

**LEGEND**

25-365-TP-12 is a composite of GTDH-2 0-5;GTDH-4 0-5;GTDH-5 0-5
25-365-TP-13 is a composite of GTDH-1 15-20;GTDH-6 15-20;GTDH-3 15-20
25-365-TP-14 is a composite of GTDH-2 15-20;GTDH-4 15-20;GTDH-5 15-20
25-365-TP-15 is a composite of GTDH-1 29-34;GTDH-6 30-35;GTDH-3 30-35
25-365-TP-16 is a composite of GTDH-2 30-34;GTDH-4 30-33.1;GTDH-5 30-35
25-365-TP-17 is a composite of GTDH-7 5-10;GTDH-8 5-10;GTDH-9 5-10
25-365-TP-18 is a composite of GTDH-7 15-19.4;GTDH-8 15-20;GTDH-9 15-20
25-365-TP-19 is a duplicate split of 25-365-TP-13
25-024-TP-1 is a composite of DT-4 0-5.0;DT-12 4.2-6.4;DT-15 4.7-6.6
25-024-TP-3 is a composite of DT-2 0-4.0;DT-8 0-5.8;DT-12 0-4.2:DT-15 0-4.7
25-024-TP-4 is a composite of DT-1 4.8-7.8;DT-3 3.7-7.4;DT-5 0-8.9
25-024-WR5 is a composite of 25-SCD-WR1, WR2A & WR2B
25-024-WR6 is a composite of 25-SCD-WR3A, WR3B, WR3C, WR4A, WR4B & WR4C

The waste rock located in the Drumlummon millsite and mine areas generally do not show much field evidence of acid rock drainage (ARD) problems. Although there is some iron oxidation in the waste rock, it is relatively minor compared to the volume of exposed rock. The waste rock piles are poorly vegetated and this is most likely due to the coarse gradation present in the piles. As discussed earlier, the waste rock paste pH data indicate that the waste rock is not acidic. Composite samples of waste rock from the Drumlummon millsite and mine were evaluated for static ABA methods to evaluate the acid generating potential and inherent neutralization capability of the waste rock. Two composite samples were collected for ABA analyses at Energy Laboratories, Inc. The laboratory analytical results are summarized in Table 3-6. The ABA data indicate that the total sulfur concentrations in the waste rock are low ranging from 0.08% to 0.10%. Low total sulfur concentrations limit the potential for ARD development. Both of the composite samples show significant positive net ABA ranging from 75 to 158, indicating that the waste rock is probably not acid generating. The inherent neutralization potential of the waste rock is further corroborated by the XRF results for calcium that showed concentrations ranging from 1.4% to 4.8%. These data indicate that calcium carbonate ($CaCO_3$) concentrations may be as high as 12.0% in the waste rock.

### 3.2.5 Mill Tailings and Waste Rock TCLP Results

Based on the laboratory analytical results for the mill tailings, splits of composite samples were selected for metals (Ag, As, Ba, Cd, Cr, Hg, Pb, and Se) Toxicity Characteristic Leaching Procedure (TCLP) analysis. Chemistry results for mill tailings show that mercury is the metal element of most concern in the Silver Creek Drainage Project area. Based on the laboratory analytical results, four composite mill tailings samples with elevated mercury concentrations (53 mg/Kg to 140 mg/Kg) were selected for TCLP analysis at Energy Laboratories in Billings, Montana. The tailings TCLP laboratory analytical results are summarized in Table 3-7. The results indicate that no elements exceeded the regulatory levels for metal toxicity under the Resource Conservation and Recovery Act (RCRA) rules for hazardous waste classification. Selenium was the only analyte detected in the TCLP analyses for mill tailings and the concentrations were well within the regulatory limit.

Splits of the two waste rock composite samples were also collected for metals TCLP analysis. The waste rock TCLP laboratory analytical results are summarized in Table 3-7. The results indicate that no elements exceeded the regulatory levels for metal toxicity under the Resource Conservation and Recovery Act (RCRA) rules for hazardous waste classification.

## 3.3 SILVER CREEK STREAM SEDIMENTS

The details of the reconnaissance stream sediment sampling program in the Silver Creek Drainage Project are contained in the Phase I Reconnaissance Site Characterization Report for the Silver Creek Drainage Project (DEQ-MWCB/Olympus, 2003a). A summary of the results of this work is presented below.

Stream sediment samples were collected from Silver Creek and Jennies Fork at an average frequency of 10 to 15 samples per stream mile or approximately every 350 to 500 feet. Samples were only collected from areas where access agreements had been signed by the land owner. Access agreements were not available for Silver Creek above Marysville, on Jennies Fork above the Great Divide Ski Area and a reach of lower Silver Creek. A total of 128 stream

**Table 3-7. TCLP Metals for Mill Tailings and Waste Rock**

| Sample ID | Ag (mg/L) | As (mg/L) | Ba (mg/L) | Cd (mg/L) | Cr (mg/L) | Hg (mg/L) | Pb (mg/L) | Se (mg/L) |
|---|---|---|---|---|---|---|---|---|
| 25-365-TP-12 | <0.5 | <0.5 | <10 | <0.1 | <0.5 | <0.02 | <0.5 | 0.2 |
| 25-365-TP-14 | <0.5 | <0.5 | <10 | <0.1 | <0.5 | <0.02 | <0.5 | 0.2 |
| 25-365-TP-16 | <0.5 | <0.5 | <10 | <0.1 | <0.5 | <0.02 | <0.5 | 0.2 |
| 25-SCD-TP-8 | <0.5 | <0.5 | <10 | <0.1 | <0.5 | <0.02 | <0.5 | <0.1 |
| 25-024-WR5 | <0.5 | <0.5 | <10 | <0.1 | <0.5 | <0.02 | <0.5 | <0.1 |
| 25-024-WR6 | <0.5 | <0.5 | <10 | <0.1 | <0.5 | <0.02 | <0.5 | <0.1 |
| Regulatory Level | 5 | 5 | 100 | 1 | 5 | 0.2 | 5 | 1 |

**LEGEND**

25-365-TP-12 is a composite of GTDH-2 0-5;GTDH-4 0-5;GTDH-5 0-5
25-365-TP-14 is a composite of GTDH-2 15-20;GTDH-4 15-20;GTDH-5 15-20
25-365-TP-16 is a composite of GTDH-2 30-34;GTDH-4 30-33.1;GTDH-5 30-35
25-SCD-TP-8 is a composite of UP2 5.5-7;UP3 5.1-7.4:UP4 0-6.1;UP8 9.4-10.5
25-024-WR5 is a composite of 25-SCD-WR1, WR2A & WR2B
25-024-WR6 is a composite of 25-SCD-WR3A, WR3B, WR3C, WR4A, WR4B & WR4C

sediment samples and six duplicates for a total of 134 were collected and analyzed by Energy Laboratories. Of these 134 samples, 92 were analyzed for arsenic, cadmium, copper, mercury, lead, zinc, total cyanide and paste pH, and the remaining 42 were analyzed for mercury only. Stream sediment sample locations are shown on Figures 3-16a through 3-16e. Laboratory chemistry results for stream sediments are presented in Table 3-8.

The stream sediment sample results showed poor correlation between XRF and laboratory analytical results. This is most likely because of variability within the sediment matrix, including particle size, moisture and organic matter content. Unlike tailings samples, which typically have consistent particles size composition because of the milling process, the sediment samples have particle sizes ranging from sand and gravel down to fine silt and clay. Besides the particle size variation, the sediment samples contained a wide variety of organic matter. The coarse-grained sediments generally contained little or no organic matter. In fine silt/clay samples, especially from beaver and other pond areas, organic matter comprised a significant portion of the sediment matrix. For these reasons and because of the poor correlation between the XRF and laboratory data, the XRF data were not considered in the sediment evaluation.

Laboratory analytical results show paste pH values ranging from 6.8 to 8.0 SU, with a mean of 7.5 SU. The following are the median concentration and enrichment relative to the background mean concentrations for each element.

**Silver Creek Stream Sediment Median Element Concentrations Compared to Background**
(quantitative laboratory results)

All Results in mg/kg

| As | Cd | Cu | Hg | Pb | Zn | T CN |
|---|---|---|---|---|---|---|
| 8.0 | a | 35.5 | 4.0 | 36.0 | 70.0 | a |
| *0.4x* | | *1.0x* | *>8.0x* | *3.2x* | *1.0x* | |

*a - Analytes Cd and total cyanide were detected in less than 6% of stream sediment samples*
*Hg was not detected above detection limit in background soils*

Cadmium was present above the laboratory detection limit of 1 mg/Kg in only three of the 92 stream sediment samples. Two of the samples had cadmium concentrations equal to the detection limit (1 mg/Kg) and the maximum cadmium concentration was 2 mg/Kg. Total cyanide was present above the detection limit of 0.5 mg/Kg in only five of the 92 stream sediment samples. The detectable values of total cyanide had median and maximum concentrations of 1.7 mg/Kg and 7.6 mg/Kg, respectively.

This comparison of stream sediment metal/metalloid concentrations to background indicates that median arsenic concentrations are significantly less than background, while copper and zinc concentrations are approximately equal to background. Lead and mercury concentrations are elevated relative to background. It should be noted that the background soil concentration of mercury was taken as 0.5 mg/Kg (half of the detection limit) since mercury was not present above the detection limit of 1 mg/Kg in the background samples. However, background soil samples collected by Pioneer Technical Services, Inc. as part of the Hazardous Materials Inventories for the Bald Mountain mine, Belmont mine, Drumlummon mine and millsite and Goldsil millsite (MDSL/AMRB, 1993a, 1993b, 1993c and 1994) had mercury concentrations ranging from less than 0.03 mg/Kg to 0.187 mg/Kg. Based on these data, the median mercury concentration could be greater than 100 times the times the mean background concentration.

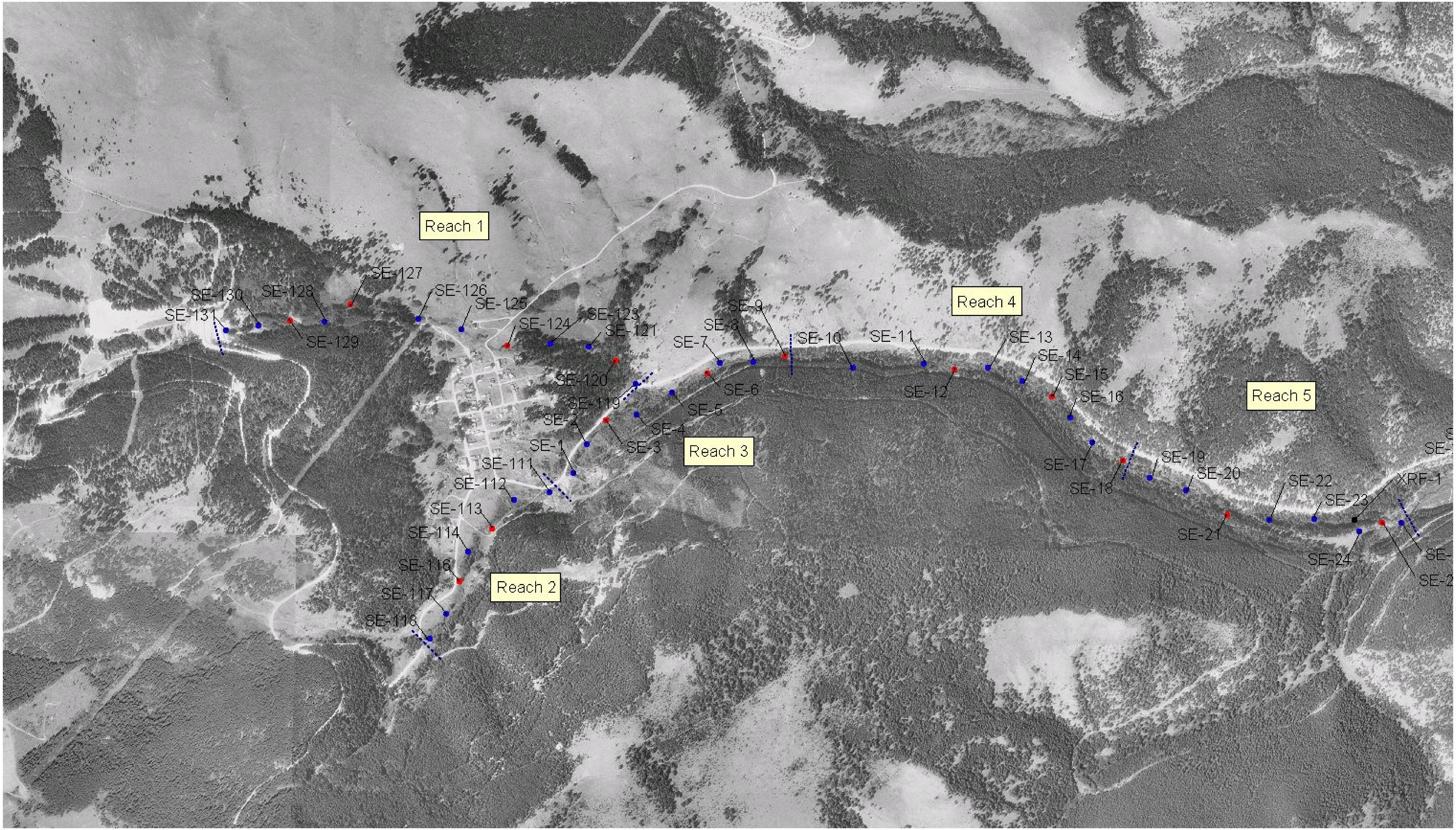
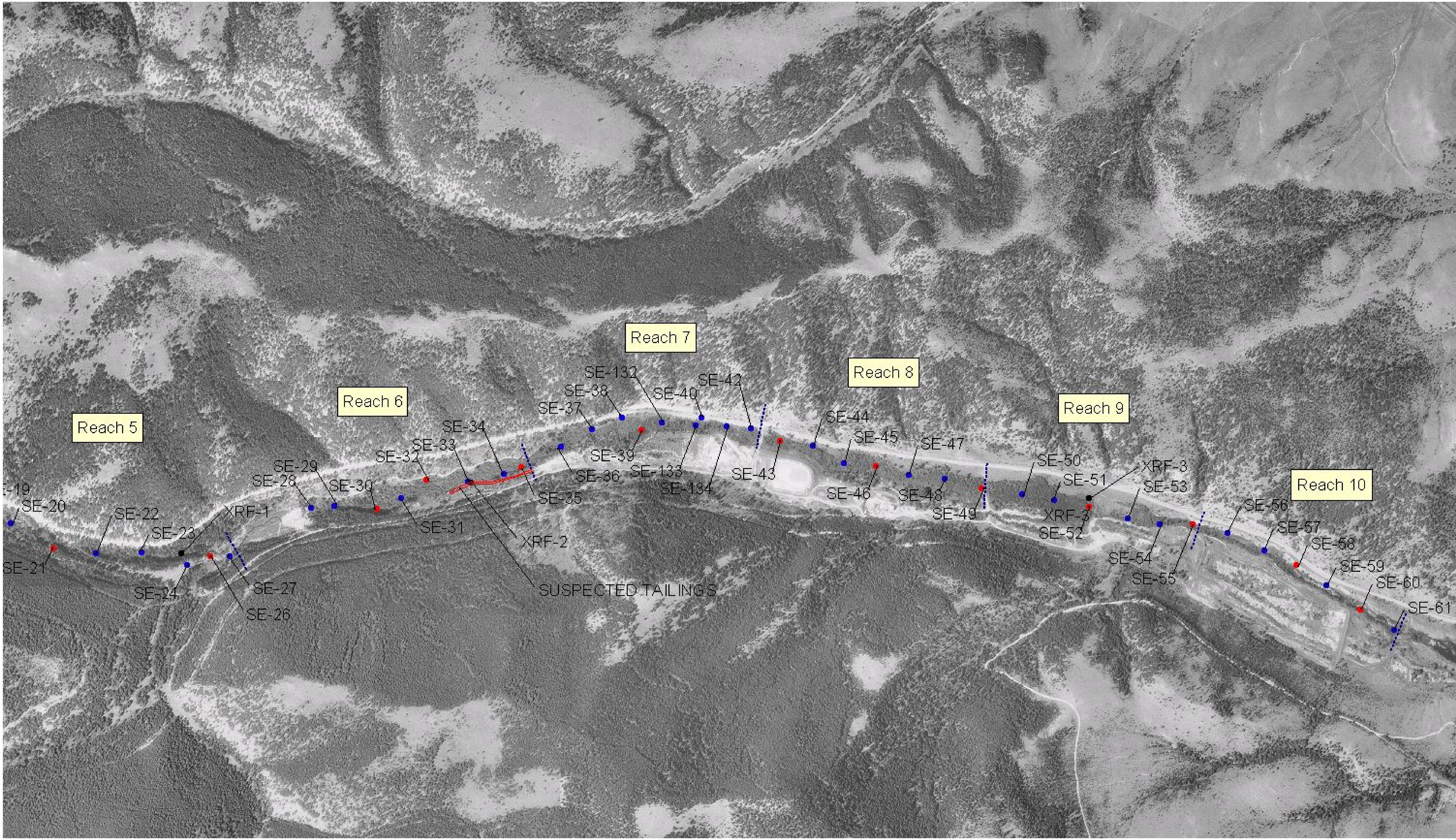





**Figure 3-16a**
**Stream Sediment Sample and Stream Reach 1 through 5 Locations**




Olympus Technical Services, Inc.

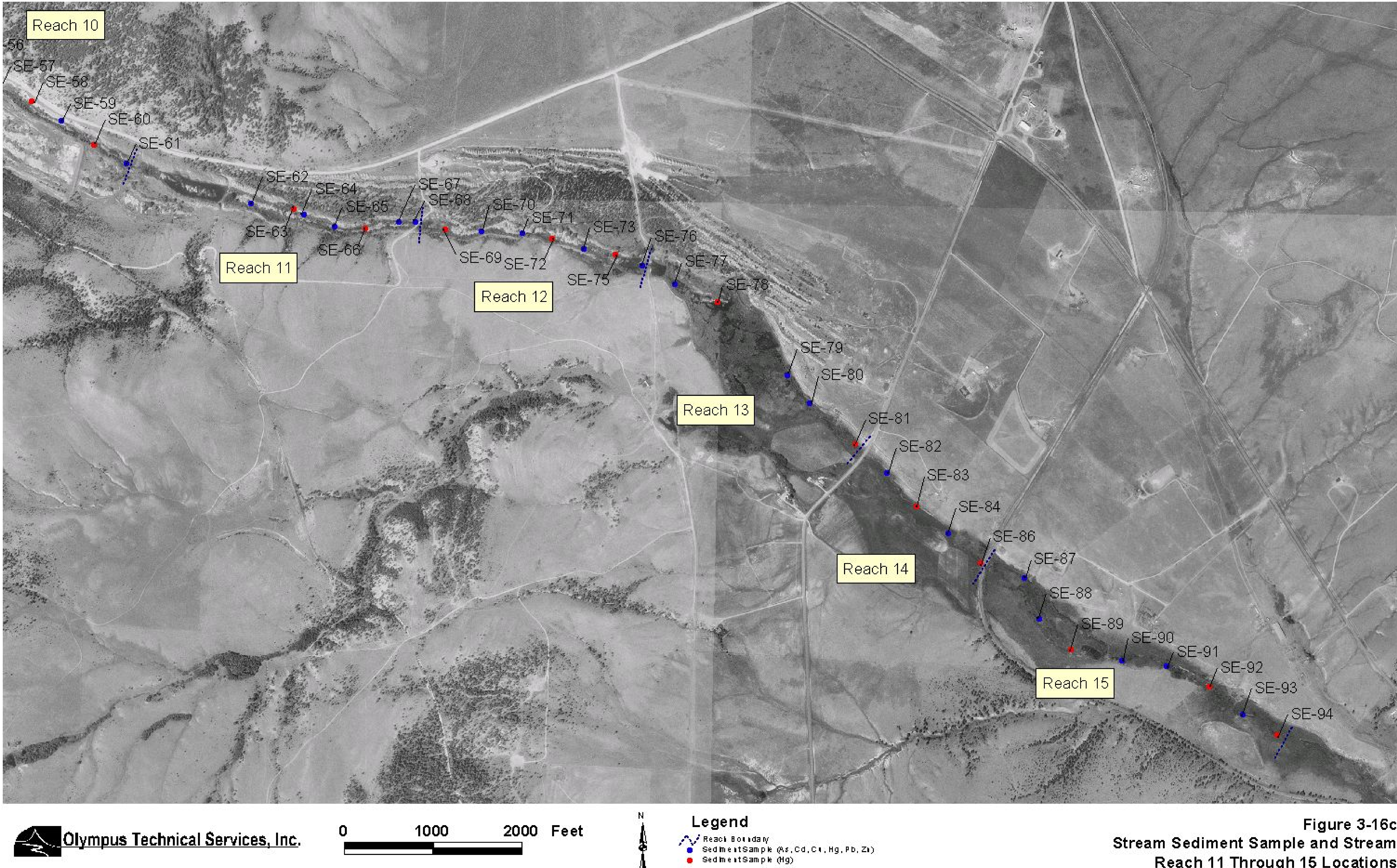
0 1000 2000 Feet

N

**Legend**

- XRF Only
- Sediment Sample (As, Cd, Cu, Hg, Pb, Zn)
- Sediment Sample (Hg)
- Reach Boundary

**Figure 3-16b**
**Stream Sediment Sample and Stream Reach 6 Through 10 Locations**




Olympus Technical Services, Inc.

**Figure 3-16c**
**Stream Sediment Sample and Stream Reach 11 Through 15 Locations**

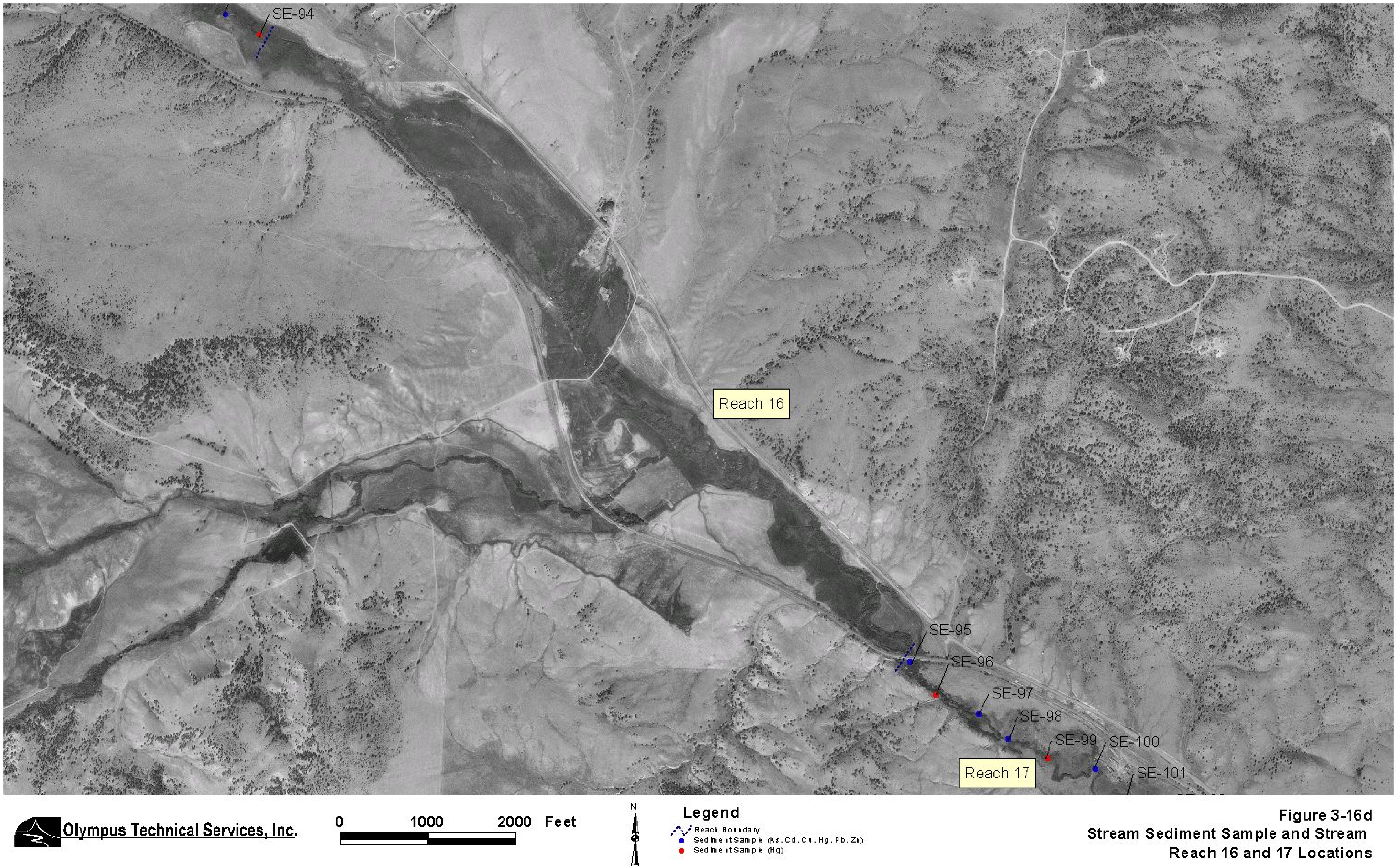



Figure 3-16d
Stream Sediment Sample and Stream
Reach 16 and 17 Locations

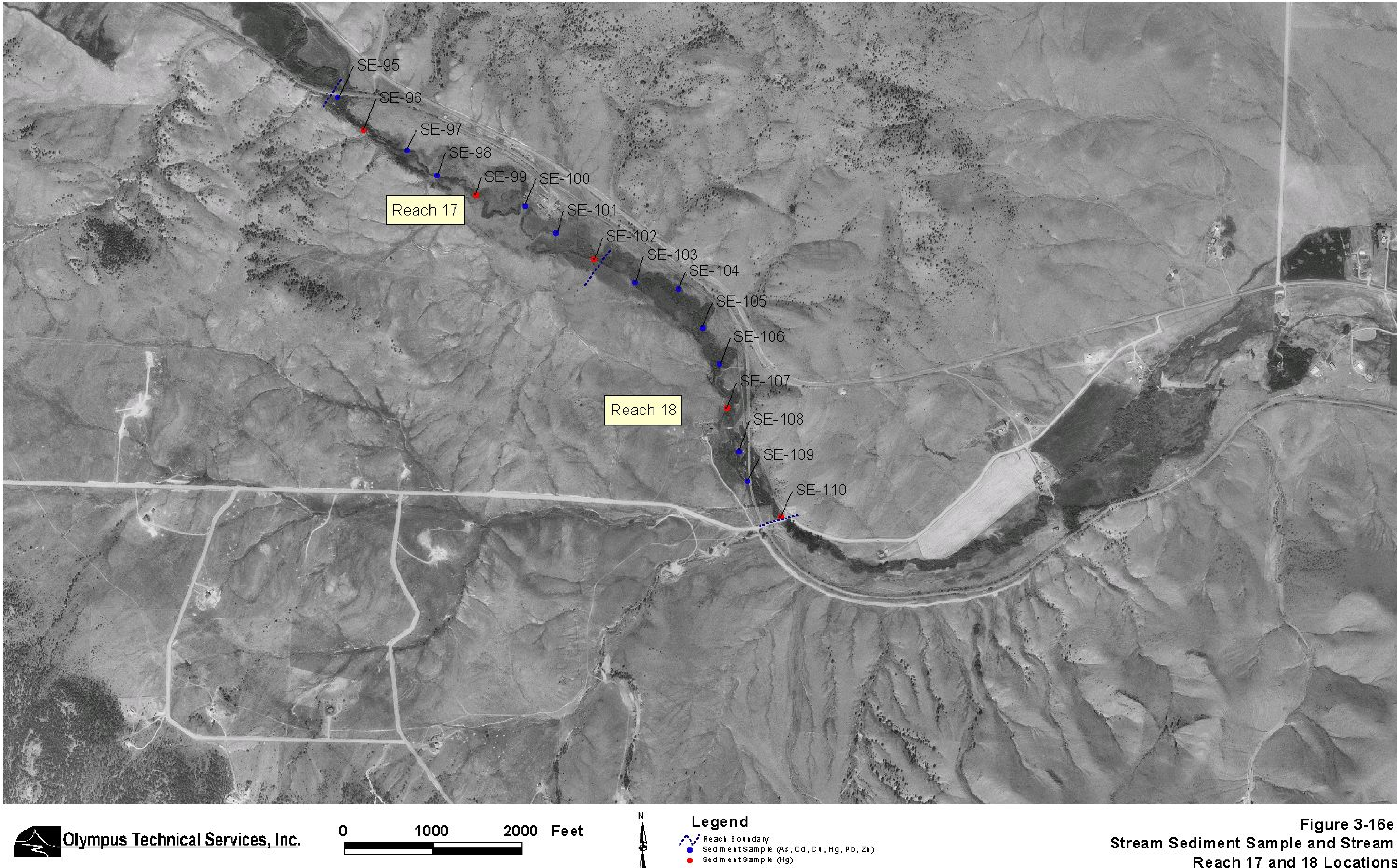



Figure 3-16e
Stream Sediment Sample and Stream
Reach 17 and 18 Locations

**Table 3-8. Laboratory Chemistry Results for Stream Sediments**

| Sample ID | As (mg/Kg) | Cd (mg/Kg) | Cu (mg/Kg) | Pb (mg/Kg) | Hg (mg/Kg) | Zn (mg/Kg) | CN (mg/Kg) | Paste pH | Stream Mile | Reach No. | Comment |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Jennies Fork** | | | | | | | | | | | |
| 25-SCD-SE-131 | <5 | <1 | 13 | 23 | <1 | 52 | <0.5 | 7.7 | 0.00 | Reach 1 | |
| 25-SCD-SE-130 | 6 | <1 | 18 | 24 | <1 | 78 | <0.5 | 7.7 | 0.07 | | |
| 25-SCD-SE-129 | | | | | <1 | | | | 0.13 | | |
| 25-SCD-SE-128 | 11 | <1 | 37 | 75 | <1 | 160 | <0.5 | 7.6 | 0.21 | | |
| 25-SCD-SE-127 | | | | | <1 | | | | 0.27 | | |
| 25-SCD-SE-126 | 14 | <1 | 52 | 93 | <1 | 156 | <0.5 | 7.5 | 0.41 | | |
| 25-SCD-SE-125 | 8 | <1 | 27 | 44 | <1 | 89 | <0.5 | 7.6 | 0.50 | | |
| 25-SCD-SE-124 | | | | | 3 | | | | 0.60 | | |
| 25-SCD-SE-123 | 8 | <1 | 24 | 37 | <1 | 103 | <0.5 | 7.6 | 0.69 | | |
| 25-SCD-SE-122 | 9 | <1 | 43 | 53 | <1 | 125 | <0.5 | 7.5 | | | Dup of SE-121 |
| 25-SCD-SE-121 | 10 | <1 | 28 | 42 | <1 | 105 | <0.5 | 7.6 | 0.77 | | |
| 25-SCD-SE-120 | | | | | <1 | | | | 0.84 | | |
| 25-SCD-SE-119 | 15 | <1 | 29 | 50 | <1 | 97 | <0.5 | 7.5 | 0.90 | | |
| **Silver Creek** | | | | | | | | | | | |
| 25-SCD-SE-118 | <5 | <1 | 6 | 11 | <1 | 23 | <0.5 | 7.8 | 0.00 | Reach 2 | |
| 25-SCD-SE-117 | 15 | <1 | 11 | 27 | <1 | 43 | <0.5 | 7.6 | 0.06 | | |
| 25-SCD-SE-116 | | | | | 1 | | | | 0.13 | | |
| 25-SCD-SE-115 | 6 | <1 | 14 | 29 | <1 | 41 | <0.5 | 7.4 | 0.20 | | Dup of SE-114 |
| 25-SCD-SE-114 | 9 | <1 | 23 | 71 | 2 | 57 | <0.5 | 7.3 | | | |
| 25-SCD-SE-113 | | | | | 14 | | | | 0.27 | | |
| 25-SCD-SE-112 | 13 | <1 | 20 | 31 | 8 | 67 | <0.5 | 7.2 | 0.34 | | |
| 25-SCD-SE-111 | 6 | <1 | 12 | 37 | 1 | 43 | <0.5 | 7.4 | 0.42 | | |
| 25-SCD-SE-1 | 15 | <2 | 14 | 35 | 1 | 45 | <0.2 | 7.6 | 0.48 | Reach 3 | |
| 25-SCD-SE-2 | 13 | <2 | 32 | 72 | 6 | 70 | <0.2 | 7.5 | 0.54 | | |
| 25-SCD-SE-3 | | | | | <1 | | | | 0.61 | | |
| 25-SCD-SE-4 | 11 | <1 | 26 | 65 | 5 | 68 | <0.2 | 7.4 | 0.67 | | |
| 25-SCD-SE-5 | 11 | <1 | 37 | 76 | 4 | 112 | <0.2 | 7.3 | 0.76 | | |
| 25-SCD-SE-6 | | | | | 8 | | | | 0.84 | | |
| 25-SCD-SE-7 | 6 | <1 | 42 | 40 | 6 | 54 | <0.2 | 6.9 | 0.88 | | |
| 25-SCD-SE-8 | 8 | <1 | 27 | 45 | 2 | 89 | <0.2 | 7.6 | 0.94 | | |
| 25-SCD-SE-9 | | | | | 12 | | | | 1.01 | | |
| 25-SCD-SE-10 | 9 | <1 | 37 | 61 | 5 | 119 | <0.2 | 7.2 | 1.15 | Reach 4 | |
| 25-SCD-SE-11 | 10 | <1 | 35 | 46 | 2 | 93 | <0.2 | 7.5 | 1.30 | | |
| 25-SCD-SE-12 | | | | | <1 | | | | 1.36 | | |
| 25-SCD-SE-13 | 5 | <1 | 33 | 35 | 1 | 67 | <0.5 | 7.1 | 1.43 | | |
| 25-SCD-SE-14 | 7 | <1 | 37 | 45 | 4 | 71 | <0.5 | 6.8 | 1.51 | | |
| 25-SCD-SE-15 | | | | | 3 | | | | 1.58 | | |
| 25-SCD-SE-16 | 7 | <1 | 43 | 47 | 5 | 99 | <0.5 | 7.4 | 1.63 | | |

**Table 3-8. Laboratory Chemistry Results for Stream Sediments**

| Sample ID | As (mg/Kg) | Cd (mg/Kg) | Cu (mg/Kg) | Pb (mg/Kg) | Hg (mg/Kg) | Zn (mg/Kg) | CN (mg/Kg) | Paste pH | Stream Mile | Reach No. | Comment |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 25-SCD-SE-17 | 6 | <1 | 33 | 70 | <1 | 76 | <0.5 | 7.7 | 1.70 | | |
| 25-SCD-SE-18 | | | | | 2 | | | | 1.78 | | |
| 25-SCD-SE-19 | 7 | <1 | 23 | 34 | 2 | 61 | <0.5 | 7.5 | 1.84 | Reach 5 | |
| 25-SCD-SE-20 | 6 | <1 | 29 | 36 | 2 | 77 | <0.5 | 7.5 | 1.92 | | |
| 25-SCD-SE-21 | | | | | 2 | | | | 2.02 | | |
| 25-SCD-SE-22 | 8 | <1 | 29 | 30 | 2 | 67 | <0.5 | 7.6 | 2.11 | | |
| 25-SCD-SE-23 | 7 | <1 | 30 | 42 | 4 | 80 | <0.5 | 7.5 | 2.20 | | |
| 25-SCD-SE-24 | 7 | <1 | 30 | 37 | 3 | 80 | <0.5 | 7.4 | 2.30 | | |
| 25-SCD-SE-25 | 7 | <1 | 34 | 39 | 3 | 86 | <0.5 | 7.5 | | | Dup of SE-24 |
| 25-SCD-SE-26 | | | | | <1 | | | | 2.35 | | |
| 25-SCD-SE-27 | 5 | <1 | 31 | 36 | 3 | 63 | <0.5 | 7.6 | 2.39 | | |
| 25-SCD-SE-28 | 7 | <1 | 37 | 31 | 4 | 60 | 7.5 | 7.5 | 2.58 | Reach 6 | |
| 25-SCD-SE-29 | 6 | <1 | 35 | 32 | 4 | 63 | <0.5 | 7.5 | 2.63 | | |
| 25-SCD-SE-30 | | | | | 3 | | | | 2.72 | | |
| 25-SCD-SE-31 | 7 | <1 | 53 | 41 | 5 | 84 | <0.5 | 7.6 | 2.77 | | |
| 25-SCD-SE-32 | | | | | 5 | | | | 2.83 | | |
| 25-SCD-SE-33 | <5 | <1 | 40 | 42 | 4 | 77 | <0.5 | 7.5 | 2.92 | | |
| 25-SCD-SE-34 | <5 | <1 | 43 | 42 | 6 | 71 | <0.5 | 7.6 | 3.00 | | |
| 25-SCD-SE-35 | | | | | 4 | | | | 3.03 | | |
| 25-SCD-SE-36 | 11 | <1 | 27 | 30 | 3 | 66 | 7.6 | 7.6 | 3.12 | Reach 7 | |
| 25-SCD-SE-37 | 10 | <1 | 31 | 33 | 2 | 73 | <0.5 | 7.6 | 3.20 | | |
| 25-SCD-SE-38 | <5 | <1 | 34 | 36 | 4 | 69 | 0.8 | 7.7 | 3.26 | | |
| 25-SCD-SE-39 | | | | | 5 | | | | 3.31 | | |
| 25-SCD-SE-132 | 13 | 2 | 107 | 81 | 11 | 148 | <0.5 | 8 | 3.35 | | |
| 25-SCD-SE-133 | 22 | 1 | 164 | 154 | 18 | 215 | <0.5 | 7.9 | 3.42 | | |
| 25-SCD-SE-40 | 6 | <1 | 53 | 51 | 10 | 103 | <0.5 | 7.6 | 3.44 | | |
| 25-SCD-SE-41 | 6 | <1 | 50 | 48 | 9 | 93 | 1 | 7.6 | | | Dup of SE-40 |
| 25-SCD-SE-134 | 8 | <1 | 64 | 59 | 10 | 98 | <0.5 | 7.6 | 3.50 | | |
| 25-SCD-SE-42 | 12 | <1 | 120 | 86 | 30 | 107 | <0.5 | 7.6 | 3.55 | | |
| 25-SCD-SE-43 | | | | | 16 | | | | 3.61 | Reach 8 | |
| 25-SCD-SE-44 | 10 | <1 | 48 | 34 | 10 | 70 | <0.5 | 7.3 | 3.68 | | |
| 25-SCD-SE-45 | 9 | <1 | 36 | 31 | 8 | 68 | <0.5 | 7.4 | 3.75 | | |
| 25-SCD-SE-46 | | | | | 5 | | | | 3.82 | | |
| 25-SCD-SE-47 | 24 | <1 | 54 | 49 | 4 | 112 | <0.5 | 7.7 | 3.89 | | |
| 25-SCD-SE-48 | 36 | <1 | 114 | 47 | 4 | 155 | <0.5 | 7.8 | 3.96 | | |
| 25-SCD-SE-49 | | | | | 2 | | | | 4.04 | | |
| 25-SCD-SE-50 | 14 | <1 | 30 | 23 | 7 | 47 | <0.5 | 7.5 | 4.12 | Reach 9 | |
| 25-SCD-SE-51 | 53 | <1 | 58 | 39 | 9 | 85 | <0.5 | 7.4 | 4.19 | | |
| 25-SCD-SE-52 | | | | | 10 | | | | 4.26 | | |

**Table 3-8. Laboratory Chemistry Results for Stream Sediments**

| Sample ID | As (mg/Kg) | Cd (mg/Kg) | Cu (mg/Kg) | Pb (mg/Kg) | Hg (mg/Kg) | Zn (mg/Kg) | CN (mg/Kg) | Paste pH | Stream Mile | Reach No. | Comment |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 25-SCD-SE-53 | 29 | <1 | 37 | 29 | 6 | 64 | <0.5 | 7.4 | 4.35 | | |
| 25-SCD-SE-54 | 26 | <1 | 40 | 32 | 4 | 71 | <0.5 | 7.8 | 4.41 | | |
| 25-SCD-SE-55 | | | | | 4 | | | | 4.48 | | |
| 25-SCD-SE-56 | 35 | <1 | 31 | 23 | 6 | 52 | <0.5 | 7.5 | 4.55 | Reach 10 | |
| 25-SCD-SE-57 | 12 | <1 | 29 | 21 | 4 | 55 | <0.5 | 7.4 | 4.63 | | |
| 25-SCD-SE-58 | | | | | 6 | | | | 4.71 | | |
| 25-SCD-SE-59 | 13 | <1 | 25 | 18 | 6 | 51 | <0.5 | 7.5 | 4.78 | | |
| 25-SCD-SE-60 | | | | | 7 | | | | 4.87 | | |
| 25-SCD-SE-61 | 14 | <1 | 22 | 25 | 5 | 58 | <0.5 | 7.9 | 4.95 | | |
| 25-SCD-SE-62 | 14 | <1 | 51 | 29 | 14 | 83 | <0.5 | 7.5 | 5.22 | Reach 11 | |
| 25-SCD-SE-63 | | | | | 3 | | | | 5.32 | | |
| 25-SCD-SE-64 | 6 | <1 | 21 | 10 | 5 | 32 | <0.5 | 7.6 | 5.34 | | |
| 25-SCD-SE-65 | <5 | <1 | 23 | 10 | 6 | 30 | <0.5 | 7.4 | 5.41 | | |
| 25-SCD-SE-66 | | | | | 5 | | | | 5.48 | | |
| 25-SCD-SE-67 | 10 | <1 | 40 | 17 | 11 | 56 | <0.5 | 7.5 | 5.55 | | |
| 25-SCD-SE-68 | 6 | <1 | 24 | 12 | 4 | 39 | <0.5 | 7.5 | 5.58 | | |
| 25-SCD-SE-69 | | | | | 5 | | | | 5.65 | Reach 12 | |
| 25-SCD-SE-70 | 5 | <1 | 46 | 27 | 9 | 54 | <0.5 | 7.8 | 5.73 | | |
| 25-SCD-SE-71 | <5 | <1 | 63 | 36 | 12 | 69 | <0.5 | 7.6 | 5.81 | | |
| 25-SCD-SE-72 | | | | | 1 | | | | 5.88 | | |
| 25-SCD-SE-73 | 9 | <1 | 29 | 17 | 4 | 46 | <0.5 | 7.3 | 5.95 | | |
| 25-SCD-SE-74 | 8 | <1 | 28 | 16 | 4 | 45 | <0.5 | 7.4 | | | Dup of SE-73 |
| 25-SCD-SE-75 | | | | | 3 | | | | 6.02 | | |
| 25-SCD-SE-76 | 7 | <1 | 18 | 10 | 2 | 33 | <0.5 | 7.4 | 6.08 | | |
| 25-SCD-SE-77 | 10 | <1 | 23 | 16 | 2 | 42 | <0.5 | 7.3 | 6.16 | Reach 13 | |
| 25-SCD-SE-78 | | | | | 1 | | | | 6.26 | | |
| 25-SCD-SE-79 | 11 | <1 | 71 | 62 | 6 | 99 | <0.5 | 7.6 | 6.47 | | |
| 25-SCD-SE-80 | 15 | <1 | 67 | 48 | 23 | 86 | <0.5 | 7.5 | 6.55 | | |
| 25-SCD-SE-81 | | | | | 9 | | | | 6.68 | | |
| 25-SCD-SE-82 | 21 | <1 | 112 | 90 | 19 | 144 | <0.5 | 7.4 | 6.77 | Reach 14 | |
| 25-SCD-SE-83 | | | | | <1 | | | | 6.86 | | |
| 25-SCD-SE-84 | 9 | <1 | 63 | 41 | 9 | 75 | <0.5 | 7.3 | 6.95 | | |
| 25-SCD-SE-85 | 8 | <1 | 85 | 57 | 10 | 84 | <0.5 | 7.3 | | | Dup of SE-84 |
| 25-SCD-SE-86 | | | | | 7 | | | | 7.05 | | |
| 25-SCD-SE-87 | 9 | 1 | 183 | 123 | 40 | 149 | <0.5 | 7.6 | 7.14 | Reach 15 | |
| 25-SCD-SE-88 | 29 | <1 | 42 | 35 | 5 | 38 | <0.5 | 7.6 | 7.24 | | |
| 25-SCD-SE-89 | | | | | 12 | | | | 7.33 | | |
| 25-SCD-SE-90 | 15 | <1 | 32 | 24 | 4 | 51 | <0.5 | 7.6 | 7.44 | | |
| 25-SCD-SE-91 | 11 | <1 | 30 | 22 | 1 | 51 | <0.5 | 7.6 | 7.54 | | |

**Table 3-8. Laboratory Chemistry Results for Stream Sediments**

| Sample ID | As (mg/Kg) | Cd (mg/Kg) | Cu (mg/Kg) | Pb (mg/Kg) | Hg (mg/Kg) | Zn (mg/Kg) | CN (mg/Kg) | Paste pH | Stream Mile | Reach No. | Comment |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 25-SCD-SE-92 | | | | | 2 | | | | 7.64 | | |
| 25-SCD-SE-93 | 6 | <1 | 17 | 12 | 6 | 39 | <0.5 | 7.3 | 7.73 | | |
| 25-SCD-SE-94 | | | | | 3 | | | | 7.82 | | |
| | | | | No Access Agreement | | | | | | Reach 16 | |
| 25-SCD-SE-95 | 7 | <1 | 54 | 36 | 10 | 73 | <0.5 | 7.5 | 9.77 | Reach 17 | |
| 25-SCD-SE-96 | | | | | 7 | | | | 9.85 | | |
| 25-SCD-SE-97 | 10 | <1 | 25 | 24 | 3 | 54 | <0.5 | 7.6 | 9.96 | | |
| 25-SCD-SE-98 | <5 | <1 | 43 | 29 | 8 | 55 | <0.5 | 7.4 | 10.04 | | |
| 25-SCD-SE-99 | | | | | 9 | | | | 10.13 | | |
| 25-SCD-SE-100 | <5 | <1 | 40 | 27 | 7 | 60 | 1.7 | 7.5 | 10.24 | | |
| 25-SCD-SE-101 | 5 | <1 | 47 | 30 | 10 | 66 | <0.5 | 7.4 | 10.33 | | |
| 25-SCD-SE-102 | | | | | 9 | | | | 10.43 | | |
| 25-SCD-SE-103 | 10 | <1 | 79 | 50 | 18 | 80 | <0.5 | 7.4 | 10.53 | Reach 18 | |
| 25-SCD-SE-104 | 7 | <1 | 72 | 43 | 12 | 78 | <0.5 | 7.4 | 10.62 | | |
| 25-SCD-SE-105 | 8 | <1 | 58 | 36 | 12 | 79 | <0.5 | 7.2 | 10.72 | | |
| 25-SCD-SE-106 | 7 | <1 | 46 | 26 | 7 | 59 | <0.5 | 7.3 | 10.80 | | |
| 25-SCD-SE-107 | | | | | 9 | | | | 10.89 | | |
| 25-SCD-SE-108 | <5 | <1 | 47 | 30 | 11 | 59 | <0.5 | 7.5 | 10.99 | | |
| 25-SCD-SE-109 | <5 | <1 | 56 | 35 | 10 | 75 | <0.5 | 7.5 | 11.06 | | |
| 25-SCD-SE-110 | | | | | 11 | | | | 11.16 | | |

**Summary Statistics**

| | As* (mg/Kg) | Cd (mg/Kg) | Cu (mg/Kg) | Pb (mg/Kg) | Hg* (mg/Kg) | Zn (mg/Kg) | CN (mg/Kg) | Paste pH |
|---|---|---|---|---|---|---|---|---|
| Mean | 10.42 | | 43.22 | 40.82 | 5.87 | 76.24 | 3.72 | 7.50 |
| Median | 8 | | 35.5 | 36 | 4 | 70 | 1.7 | 7.5 |
| Maximum | 53 | 2 | 183 | 154 | 40 | 215 | 7.6 | 8.0 |
| Minimum | <5 | <1 | 6 | 10 | <1 | 23 | <0.5 | 6.8 |
| No. Samples | 92 | | 92 | 92 | 134 | 92 | 5 | 92 |

*Values below detection limit taken as 1/2 detection limit for statistics

To evaluate the metal/metalloid concentrations in stream sediments in more detail, Silver Creek and Jennies Fork were divided into 18 separate stream reaches. These reaches were selected based on a number of factors including: reach length, the number of samples per reach, waste sources within a reach and physical features such as road crossings. The reaches are shown on Figures 3-16a through 3-16e. Table 3-9 summarizes the mean, median and maximum concentration statistics for stream sediments by stream reach. In general, the results indicate consistent patterns among reaches, with peak metal concentrations occurring in Reaches 7, 8, 14 and 15. Reaches 7 and 8 are adjacent to the Goldsil tailings and millsite. Reaches 14 and 15 are downstream from Birdseye Road.

Evaluation of the trends in arsenic, copper, lead, mercury and zinc concentrations in stream sediments show some distinctive patterns. First, the maximum, mean and median metal/metalloid concentrations typically have local minimums in Reaches 5 and/or 6, located above the Goldsil tailings and millsite, and have local maximums in Reach 7, which is adjacent to the Goldsil tailings. This indicates that the Goldsil tailings are a significant source of metals to Silver Creek, most likely from the erosion of mill tailings into Silver Creek. Second, the maximum, mean and median metal concentrations typically have a local minimum in Reaches 10, 11 or 12 and another local maximum in Reach 14. This would indicate that metals are attenuated in the beaver and placer tailings ponds that Silver Creek flows through in Reaches 10, 11 and 12. Reach 14 is located between Birdseye Road and the western-most railroad crossing. Reach 14 is also directly below the large placer tailings area (Reaches 12 and 13), and an old processing facility that was discovered during the Phase I Reconnaissance (DEQ-MWCB/Olympus, 2003a).

## 3.4 BUCK LAKE SEDIMENTS

Two composite sediment samples were collected from Buck Lake (Figure 1-7). Sample 25-SCD-BL-1 was collected from the eastern (downstream) half of Buck Lake and sample 25-SCD-BL-2 was collected from the western (upstream) half of Buck Lake. Each sample was composited from five discreet sediment samples collected from the lake bottom. The composite points are shown on Figure 3-17. The discreet samples were collected by driving a two-inch PVC pipe into the lake bottom to obtain a core sample.

Both composite samples were analyzed by Energy Laboratories for As, Cd, Cu, Pb, Hg, Zn, total cyanide and paste pH, and were screened for a multi-element suite using a portable XRF analyzer. The laboratory chemistry results for the Buck Lake sediment samples are presented below:

| Sample ID | As (mg/Kg) | Cd (mg/Kg) | Cu (mg/Kg) | Pb (mg/Kg) | Hg (mg/Kg) | Zn (mg/Kg) | CN (mg/Kg) | Paste pH |
|---|---|---|---|---|---|---|---|---|
| 25-SCD-BL1 | 5 | <1 | 26 | 24 | 12 | 53 | <0.5 | 7.7 |
| 25-SCD-BL2 | 6 | <1 | 49 | 26 | 9 | 66 | <0.5 | 7.5 |

The As (5 and 6 mg/Kg), Cu (26 and 49 mg/Kg), Pb (24 and 26 mg/Kg), Hg (9 and 12 mg/Kg) and Zn (53 and 66 mg/Kg) concentrations are within the range of concentrations found for the elements in the stream sediment samples. Cadmium concentrations were less than the laboratory detection limits.

**Table 3-9. Laboratory Chemistry Summary Statistics for Stream Sediments by Reach**

| | Reach Mean | | | | | Reach Median | | | | | Reach Maximum | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reach | As* (mg/Kg) | Cu (mg/Kg) | Pb (mg/Kg) | Hg* (mg/Kg) | Zn (mg/Kg) | As* (mg/Kg) | Cu (mg/Kg) | Pb (mg/Kg) | Hg* (mg/Kg) | Zn (mg/Kg) | As* (mg/Kg) | Cu (mg/Kg) | Pb (mg/Kg) | Hg* (mg/Kg) | Zn (mg/Kg) |
| 1 | 9.3 | 30.1 | 49.0 | 0.7 | 107.2 | 9.0 | 28.0 | 44.0 | 0.5 | 103 | 15.0 | 52.0 | 93.0 | 3 | 160 |
| 2 | 8.6 | 14.3 | 34.3 | 3.4 | 45.7 | 7.5 | 13.0 | 30.0 | 1 | 43 | 15.0 | 23.0 | 71.0 | 14 | 67 |
| 3 | 10.7 | 29.7 | 55.5 | 4.9 | 73.0 | 11.0 | 29.5 | 55.0 | 5 | 69 | 15.0 | 42.0 | 76.0 | 12 | 112 |
| 4 | 7.3 | 36.3 | 50.7 | 2.6 | 87.5 | 7.0 | 36.0 | 46.5 | 2 | 84.5 | 10.0 | 43.0 | 70.0 | 5 | 119 |
| 5 | 6.7 | 29.4 | 36.3 | 2.4 | 73.4 | 7.0 | 30.0 | 36.0 | 2 | 77 | 8.0 | 34.0 | 42.0 | 4 | 86 |
| 6 | 5.0 | 41.6 | 37.6 | 4.4 | 71.0 | 6.0 | 40.0 | 41.0 | 4 | 71 | 7.0 | 53.0 | 42.0 | 6 | 84 |
| 7 | 10.1 | 72.2 | 64.2 | 10.2 | 108.0 | 10.0 | 53.0 | 51.0 | 9.5 | 98 | 22.0 | 164.0 | 154.0 | 30 | 215 |
| 8 | 19.8 | 63.0 | 40.3 | 7.0 | 101.3 | 17.0 | 51.0 | 40.5 | 5 | 91 | 36.0 | 114.0 | 49.0 | 16 | 155 |
| 9 | 30.5 | 41.3 | 30.8 | 6.7 | 66.8 | 27.5 | 38.5 | 30.5 | 6.5 | 67.5 | 53.0 | 58.0 | 39.0 | 10 | 85 |
| 10 | 18.5 | 26.8 | 21.8 | 5.7 | 54.0 | 13.5 | 27.0 | 22.0 | 6 | 53.5 | 35.0 | 31.0 | 25.0 | 7 | 58 |
| 11 | 7.7 | 31.8 | 15.6 | 6.9 | 48.0 | 6.0 | 24.0 | 12.0 | 5 | 39 | 14.0 | 51.0 | 29.0 | 14 | 83 |
| 12 | 6.3 | 36.8 | 21.2 | 5.0 | 49.4 | 7.0 | 29.0 | 17.0 | 4 | 46 | 9.0 | 63.0 | 36.0 | 12 | 69 |
| 13 | 12.0 | 53.7 | 42.0 | 8.2 | 75.7 | 11.0 | 67.0 | 48.0 | 6 | 86 | 15.0 | 71.0 | 62.0 | 23 | 99 |
| 14 | 12.7 | 86.7 | 62.7 | 9.1 | 101.0 | 9.0 | 85.0 | 57.0 | 9 | 84 | 21.0 | 112.0 | 90.0 | 19 | 144 |
| 15 | 14.0 | 60.8 | 43.2 | 9.1 | 65.6 | 11.0 | 32.0 | 24.0 | 4.5 | 51 | 29.0 | 183.0 | 123.0 | 40 | 149 |
| 16 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 17 | 5.4 | 41.8 | 29.2 | 7.9 | 61.6 | 5.0 | 43.0 | 29.0 | 8.5 | 60 | 10.0 | 54.0 | 36.0 | 10 | 73 |
| 18 | 6.2 | 59.7 | 36.7 | 11.3 | 71.7 | 7.0 | 57.0 | 35.5 | 11 | 76.5 | 10.0 | 79.0 | 50.0 | 18 | 80 |

*Values below detection limit taken as 1/2 detection limit

NA - No access agreement executed for Stream Reach 16


Olympus Technical Services, Inc.

| | | |
|---|---|---|
| DRAWN: KSR | SCALE: AS SHOWN | BUCK LAKE SEDIMENT SAMPLE LOCATIONS |
| CHECKED: CRS | JOB NO: A1348 | |
| DATE: 4/2003 | FILE: A1348BuckLk.dwg | |

FIGURE 3-17

## 3.5 PLACER TAILINGS CHARACTERIZATION

Placer tailings are contained throughout much of the Silver Creek Drainage Project area, but most are concentrated in the area between the Goldsil millsite and Birdseye Road. Placer tailings generally exist in three forms in the Silver Creek drainage:

- older placer piles in the upper portion of the drainage (primarily above the Goldsil tailings) from early placer operations;

- fine-grained, unprocessed overburden piles that were stripped to allow access to the stream gravels/cobbles; and

- coarse-grained rock piles consisting of stream gravels and cobbles.

Most of the older, upstream placer workings appear to have been small operations where individuals probably hand shoveled stream gravel for gold processing by panning and/or sluice box methods or larger areas that were mined by hydraulicking. The volume of placer tailings increases significantly below the Goldsil millsite probably due to the use of mechanized placer methods employing dredges. No detailed topographic surveys nor volume estimates were done for the placer tailings. Reconnaissance surveys were done to show the approximate location of the more significant placer tailings areas. Figures 1-7 and 1-8 show the location of the larger placer tailings piles. Many of the overburden-type placer tailings piles in the Silver Creek drainage have established stands of vegetation and are for the most part naturally reclaimed.

A group of placer tailings piles are located on a bench north of Silver Creek, between Little Falcon Road and Birdseye Road. The bench appears to have been mined by a dragline dredge. There are a few small overburden piles located along the northern perimeter of the bench area. The remaining placer tailing piles in the interior are coarse-grained gravels and cobbles. A sporting clay shooting range is now located in this area. The range has numerous shooting stations which are strategically located to use the placer tailings piles to separate the stations. The objective of the placer tailings characterization was the large area between the Goldsil millsite and Birdseye Road.

A total of 38 placer tailings samples were collected and screened for a multi-element suite using a portable XRF analyzer. The XRF analytical results were generally below detection limits, indicating that the metal concentrations are generally low. Eight composite samples were prepared for quantitative laboratory analysis. Five of the composite samples were from near-stream sources and were composited by stream reach to evaluate the chemistry of fine-grained placer tailings piles. The remaining placer pile samples were composited from a placer tailings pile located along Marysville Road (just west of the intersection with Little Falcon Road), from west of the Upper Pond and from south of the Lower Pond. The three composite samples from outside of the immediate stream corridor were also evaluated for borrow source suitability. The placer tailings sample locations are shown on Figure 3-18.

The placer tailings laboratory chemistry results are summarized in Table 3-10. Paste pH values ranged from 7.2 to 8.1 SU, with a mean of 7.7 SU. The following are the mean concentration and enrichment relative to the background mean concentrations for each element.

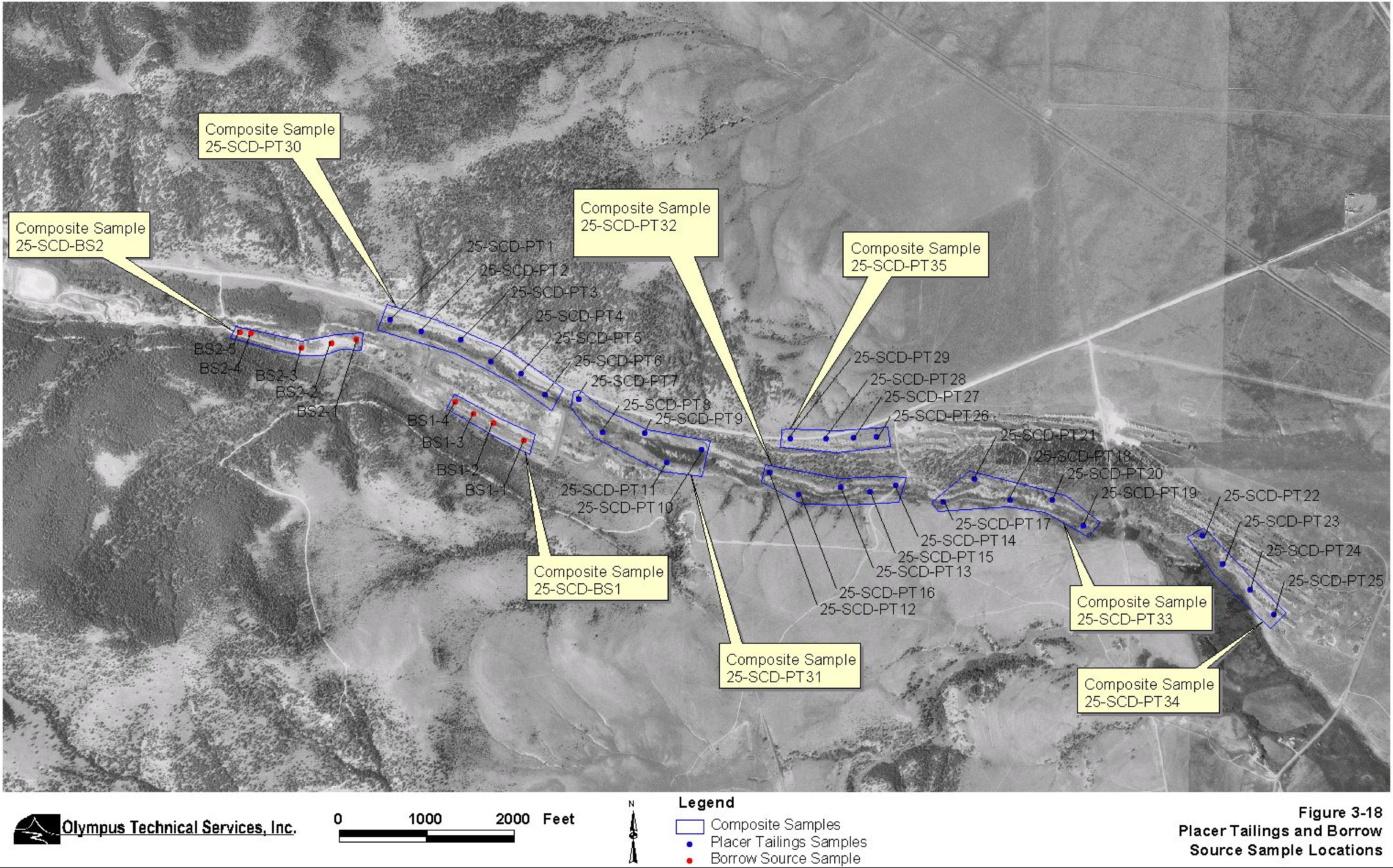



**Figure 3-18**
**Placer Tailings and Borrow Source Sample Locations**

**Table 3-10. Laboratory Chemistry Results for Placer Tailings**

| Sample ID | As (mg/Kg) | Cd (mg/Kg) | Cu (mg/Kg) | Pb (mg/Kg) | Hg* (mg/Kg) | Zn (mg/Kg) | CN (mg/Kg) | Paste pH | Comment |
|---|---|---|---|---|---|---|---|---|---|
| 25-SCD-BS1 | 19 | <1 | 34 | 21 | 3 | 59 | <0.5 | 8.1 | Composite of BS1-1, BS1-2, BS1-3 & BS1-4 |
| 25-SCD-BS2 | 52 | <1 | 29 | 19 | 2 | 60 | <0.5 | 8.1 | Composite of BS2-1, BS2-2, BS2-3, BS2-4 & BS2-5 |
| 25-SCD-PT-30 | 18 | <1 | 23 | 17 | <1 | 55 | <0.5 | 7.5 | Composite of PT1, PT2, PT3, PT4, PT6 & PT6 |
| 25-SCD-PT-31 | 21 | <1 | 19 | 15 | <1 | 53 | <0.5 | 7.4 | Composite of PT7, PT8, PT9, PT10 & PT11 |
| 25-SCD-PT-32 | 42 | <1 | 35 | 23 | 4 | 59 | <0.5 | 7.6 | Composite of PT12, PT13, PT14, PT15 & PT16 |
| 25-SCD-PT-33 | 32 | <1 | 43 | 44 | 7 | 71 | <0.5 | 7.6 | Composite of PT17, PT18, PT19, PT20 & PT21 |
| 25-SCD-PT-34 | 19 | <1 | 16 | 12 | <1 | 34 | <0.5 | 7.2 | Composite of PT22, PT23, PT24 & PT25 |
| 25-SCD-PT-35 | 24 | <1 | 32 | 22 | 3 | 57 | <0.5 | 8.1 | Composite of PT26, PT27, PT28 & PT29 |
| Mean | 28.4 | <1 | 28.9 | 21.6 | 2.6 | 56.0 | <0.5 | 7.7 | |
| Maximum | 52 | <1 | 43 | 44 | 7 | 71 | <0.5 | 8.1 | |
| Minimum | 18 | <1 | 16 | 12 | <1 | 34 | <0.5 | 7.2 | |

*Values below detection limit taken as 1/2 detection limit for statistics

**Placer Tailings Mean Element Concentrations Compared to Background** (quantitative laboratory results)

All Results in mg/kg

| As | Cd | Cu | Hg | Pb | Zn | T CN |
|---|---|---|---|---|---|---|
| 28.4 | a | 28.9 | 2.6 | 21.6 | 56.0 | a |
| *1.1x* | | *0.9x* | *>5.2x* | *1.9x* | *0.81x* | |

*a - Analytes Cd and total cyanide were not detected in placer tailings samples*
*Hg was not detected above detection limit in background soils*

With the exception of mercury, the mean element concentrations are near mean background soil concentration or are not significantly elevated above background. Of the eight composite samples collected, five contained mercury above the detection limit. Three of these samples were located out of the main stream corridor, and two were located within the stream corridor. The highest mercury concentration (7 mg/Kg) was observed in the placer tailings piles along Silver Creek in Reach 12. The second highest mercury concentration (4 mg/Kg) was observed in the placer tailings piles along Silver Creek in Reach 11. The remaining detectable mercury concentrations were observed in the placer tailings pile along Marysville Road (3 mg/Kg), in a placer tailings pile along the southern perimeter of the Lower Pond (3 mg/Kg) and in a placer tailings pile west of the Upper Pond (2 mg/Kg).

## 3.6 SURFACE WATER CHARACTERISTICS

A total of 173 surface samples were collected during previous investigations from 74 reported location descriptions in the Silver Creek drainage basin. The sample results are presented in Table 3-11. The most comprehensive of the previous surface water sampling was completed by Maxim (DEQ-AMRB/Maxim, 1996). This is also the most current of the previous studies, and most representative of the current, post-active mining and milling conditions. Maxim collected surface water samples from 11 sample stations from October 1995 through August 1996. Water quality analytical data from surface water samples indicated that concentrations of several metals, arsenic, cyanide and total dissolved solids occasionally exceeded either Federal secondary water quality standards, Montana human health standards or Federal aquatic life standards. Aluminum concentrations (exceeding aquatic standards) along with iron and manganese (exceeding Montana human health standards) were the most common metals to exceed standards. Arsenic, cadmium, copper, lead, mercury, zinc and cyanide exceeded Montana and aquatic standards only occasionally. Total dissolved solids exceeded Federal drinking water secondary standards in three samples.

Surface water data collected by the MDHES, MDFWP and the Bureau of Land Management were reported in an operating permit application prepared by Goldsil Mining and Milling, Inc. (Goldsil Mining and Milling, Inc., 1984a and 1984b). Surface water was reported as excellent with the exception of detections of mercury occasionally reported. The water was classified as non-saline, very hard, calcium-bicarbonate type with low concentration of turbidity and metals. Except for mercury, the water would meet all federal water quality standards (DEQ-AMRB/Maxim, 1996).

**Table 3-11. Summary of Silver Creek Drainage Surface Water Chemistry Results**

| Sample Station | Sample Date | Sample Location | Medium | Discharge (cfs) | Field pH (s.u.) | Lab pH (s.u.) | Field Specific Conductivity (umhos/cm) | Lab Specific Conductivity (umhos/cm) | Lab Turbidity (JTU) | Water Temp (C) | Oxidation Reduction Potential (mv) | Ag (ug/L) Total/Dissolved | Al (ug/L) Total/Dissolved | As (ug/L) Total/Dissolved | Ba (ug/L) Total/Dissolved | Cd (ug/L) Total/Dissolved | Co (ug/L) | Cr (ug/L) Total/Dissolved | Cu (ug/L) Total/Dissolved | Fe (ug/L) Total/Dissolved | Hg (ug/L) Total/Dissolved | Mn (ug/L) Total/Dissolved | Ni (ug/L) Total/Dissolved |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | WQB-7-Human Health Standard | Surface Water | | | | | | | | | 100 | | 18 | 2000 | 5 | | 100 | 1300 | 300 | 0.05 | 50 | 100 |
| | | WQB-7 Acute Aquatic Life Standard | Surface Water | | | | | | | | | 13.4* | 750 | 340 | | 4.3* | | NA** | 26.9* | | 1.7 | | 843.3* |
| | | WQB-7 Chronic Aquatic Life Standard | Surface Water | | | | | | | | | | 87 | 150 | | 0.45* | | NA** | 16.9* | 1000 | 0.91 | | 93.8* |
| Culvert Intake | 03/27/02 | Silver Crk Ranchette Rd. | Surface Water | | | | | | | | | <5/ | | 11/ | <100/ | <1/ | | <10/ | 20/ | 1090/ | <1/ | 120/ | <10/ |
| Transfer Station Rd | 03/27/02 | Silver Crk - at Transfer Station Rd. | Surface Water | | | | | | | | | <5/ | | 5/ | <100/ | <1/ | | <10/ | <10/ | <30/ | <1/ | <10/ | <10/ |
| 25-200-SW-01 | 10/11/95 | Rawhide Gulch at Ski road | Surface Water | 0.20 | 7.4 | 8.0 | 188 | 173 | | 8.0 | -240 | <50/<50 | <200/<200 | 1/1 | <200/<200 | <.2/<.2 | | <10/<10 | 1/<1 | 80/<50 | <.2/<.2 | <15/<15 | <2/<2 |
| 25-200-SW-01 | 02/08/96 | Rawhide Gulch at Ski road | Surface Water | 0.02 | 6.7 | 7.3 | 186 | 160 | | 6.0 | | <50/<50 | 300/<200 | 1/1 | <200/<200 | <.2/<.2 | | <10/<10 | <5/<5 | 280/<50 | <.2/<.2 | <15/<15 | <2/<2 |
| 25-200-SW-01 | 05/01/96 | Rawhide Gulch at Ski road | Surface Water | 0.28 | 6.8 | 8.2 | 224 | 170 | | 4.0 | | <50/<50 | <200/<200 | <1/<1 | <200/<200 | <.2/<.2 | | <10/<10 | <5/<5 | <50/<50 | <.2/<.2 | <15/<15 | <2/<2 |
| 25-200-SW-01 | 08/28/96 | Rawhide Gulch at Ski road | Surface Water | 0.13 | 7.0 | 7.8 | 162 | 180 | | 10.0 | | <50/<50 | 500/<200 | 2/2 | <200/<200 | 2.9/1.4 | | <10/<10 | <2/2< | 510/80 | <.2/<.2 | 60/23 | 2/<2 |
| 25-200-SW-02 | 10/11/95 | Silver Creek at Marysville | Surface Water | 1.32 | 7.4 | 7.9 | 192 | 187 | | 9.0 | | <50/<50 | <200/<200 | 2/2 | <200/<200 | <.2/<.2 | | <10/<10 | <5/<1 | 50/<50 | .2/.2 | <15/<15 | <2/<2 |
| 25-200-SW-02 | 02/08/96 | Silver Creek at Marysville | Surface Water | 0.46 | 7.6 | 7.4 | 228 | 234 | | 7.0 | | <50/<50 | <200/<200 | 2/2 | <200/<200 | <.2/<.2 | | <10/<10 | <5/<5 | 290/<50 | <.2/<.2 | 25/<15 | <2/<2 |
| 25-200-SW-02 | 05/01/96 | Silver Creek at Marysville | Surface Water | 1.70 | 7.9 | 8.2 | 245 | 242 | | 8.0 | | <50/<50 | 400/<200 | 2/2 | <200/<200 | <.2/<.2 | | <10/<10 | <5/<5 | 290/<50 | <.2/<.2 | 20/<15 | <2/<2 |
| 25-200-SW-02 | 08/28/96 | Silver Creek at Marysville | Surface Water | 1.22 | 6.2 | 7.9 | 233 | 267 | | 12.0 | | <50/<50 | 900/<200 | 2/2 | <200/<200 | <.2/<.2 | | <10/<10 | 4/<2 | 80/18 | <.2/<.2 | 56/49 | <2/<2 |
| 25-200-SW-02A | 08/28/96 | Silver Creek immediately below Drumlummon waste rock pile | Surface Water | | 7.0 | 8.0 | 231 | 284 | | 12.0 | | <50/<50 | 3200/<200 | 5/1 | <200/<200 | 5/1.6 | | <10/<10 | 6/3 | 2690/190 | <.2/<.2 | 122/63 | <2/<2 |
| 25-200-SW-03 | 10/11/95 | Jennies Fork; at County Road | Surface Water | 0.40 | 7.5 | 8.4 | 325 | 276 | | 9.5 | | <50/<50 | <200/<200 | 2/2 | <200/<200 | <.2/<.2 | | <10/<10 | 3/<1 | 200/<50 | <.2/<.2 | 38/<15 | <2/<2 |
| 25-200-SW-03 | 02/08/96 | Jennies Fork; at County Road | Surface Water | 0.67 | 8.0 | 7.9 | 300 | 297 | | 4.3 | | <50/<50 | 300/<200 | 3/3 | <200/<200 | <.2/<.2 | | <10/<10 | <5/<5 | 370/<50 | <.2/<.2 | 43/<15 | <2/<2 |
| 25-200-SW-03 | 05/01/96 | Jennies Fork; at County Road | Surface Water | 0.74 | 6.6 | 8.4 | 300 | 271 | | 5.0 | | <50/<50 | 400/<200 | 3/2 | <200/<200 | <.2/<.2 | | <10/<10 | <5/<5 | 330/<50 | <.2/<.2 | 53/<15 | <2/<2 |
| 25-200-SW-04 | 10/11/95 | Silver Creek at Skid Road (continuous recorder station) | Surface Water | 1.53 | 7.2 | 8.2 | 232 | 276 | | 10.0 | | <50/<50 | <200/<200 | 2/2 | <200/<200 | <.2/<.2 | | <10/<10 | 3/<1 | 80/<50 | <.2/<.2 | 18/<15 | <2/<2 |
| 25-200-SW-04 | 02/08/96 | Silver Creek at Skid Road (continuous recorder station) | Surface Water | 1.57 | 7.6 | 7.2 | 245 | 230 | | 6.0 | | <50/<50 | 2700/<200 | 7/2 | <200/<200 | <.2/<.2 | | <10/<10 | 18/<5 | 2630/<50 | <.2/<.2 | 2940/<15 | <2/<2 |
| 25-200-SW-04 | 05/01/96 | Silver Creek at Skid Road (continuous recorder station) | Surface Water | 4.29 | 6.5 | 8.3 | 551 | 236 | | 5.0 | | <50/<50 | 800/<200 | 3/3 | <200/<200 | <.2/<.2 | | <10/<10 | <5/<5 | 750/<50 | <.2/<.2 | 61/<15 | <2/<2 |
| 25-200-SW-04 | 08/28/96 | Silver Creek at Skid Road (continuous recorder station) | Surface Water | 1.75 | 6.8 | 8.2 | 250 | 293 | | 12.0 | | <50/<50 | 500/<200 | 2/2 | <200/<200 | 6/6 | | <10/<10 | 3/<2 | 590/100 | <.2/<.2 | 520/31 | <2/<2 |
| 25-200-SW-05 | 10/11/95 | Sawmill Gulch | Surface Water | 0.38 | 8.0 | 8.4 | 310 | 355 | | 12.0 | | <50/<50 | <200/<200 | 4/3 | <200/<200 | <.2/<.2 | | <10/<10 | 6/<1 | 150/<50 | <.2/<.2 | 22/<15 | <2/<2 |
| 25-200-SW-05 | 02/08/96 | Sawmill Gulch | Surface Water | 0.75 | 7.9 | 7.4 | 354 | 298 | | 6.0 | | <50/<50 | 700/<200 | 5/2 | <200/<200 | <.2/<.2 | | <10/<10 | <5/<5 | 510/<50 | <.2/<.2 | 28/<15 | <2/<2 |
| 25-200-SW-05 | 05/01/96 | Sawmill Gulch | Surface Water | 3.32 | 8.1 | 8.5 | 374 | 375 | | 8.0 | | <50/<50 | 700/<200 | 3/3 | <200/<200 | <.2/<.2 | | <10/<10 | <5/<5 | 340/<50 | <.2/<.2 | 18/<15 | <2/<2 |
| 25-200-SW-06 | 10/11/95 | Silver Creek immediately above reclaimed tailings channel | Surface Water | 1.60 | 3.5 | 8.5 | 335 | 296 | | 13.0 | | <50/<50 | 900/<200 | 4/2 | <200/<200 | <.2/<.2 | | <10/<10 | 6/<1 | 830/<50 | .4/.2 | 55/33 | <2/<2 |
| 25-200-SW-06 | 02/08/96 | Silver Creek immediately above reclaimed tailings channel | Surface Water | 2.15 | 8.1 | 7.7 | 317 | 297 | | 4.0 | | <50/<50 | 500/<200 | 2/2 | <200/<200 | <.2/<.2 | | <10/<10 | <5/<5 | 460/<50 | <.2/<.2 | 530/<15 | <2/<2 |
| 25-200-SW-06 | 05/01/96 | Silver Creek immediately above reclaimed tailings channel | Surface Water | 8.65 | 7.2 | 8.5 | 382 | 328 | | 6.0 | | <50/<50 | 400/<200 | 3/3 | <200/<200 | <.2/<.2 | | <10/<10 | <5/<5 | 280/<50 | <.2/<.2 | 31/<15 | <2/<2 |
| 25-200-SW-06 | 08/28/96 | Silver Creek immediately above reclaimed tailings channel | Surface Water | 2.31 | 7.8 | 8.4 | 288 | 323 | | 16.0 | | <50/<50 | 400/<200 | 4/2 | <200/<200 | 8/2 | | <10/<10 | 4/4 | 400/70 | <.2/<.2 | 44/34 | <2/<2 |
| 25-200-SW-07 | 10/11/95 | Silver Creek at Goldsil, second culvert | Surface Water | 1.23 | 7.6 | 8.3 | 328 | 395 | | 11.0 | | <50/<50 | <200/<200 | 8/8 | <200/<200 | <.2/<.2 | | <10/<10 | 3/<1 | 160/<50 | <.2/<.2 | 31/29 | <2/<2 |
| 25-200-SW-07 | 10/11/95 | Duplicate 25-200-SW-07 (10/11/95) | Surface Water | 1.23 | 7.6 | 8.1 | 328 | 395 | | 11.0 | | <50/<50 | <200/<200 | 8/8 | <200/<200 | <.2/<.2 | | <10/<10 | 1/<1 | 140/<50 | <.2/<.2 | 32/29 | <2/<2 |
| 25-200-SW-07 | 02/08/96 | Silver Creek at Goldsil, second culvert | Surface Water | 4.10 | 7.8 | 7.2 | 282 | 288 | | 7.0 | | <50/<50 | 200/<200 | 8/4 | <200/<200 | <.2/<.2 | | <10/<10 | <5/<5 | 530/70 | <.2/<.2 | 82/30 | <2/<2 |
| 25-200-SW-07 | 05/01/96 | Silver Creek at Goldsil, second culvert | Surface Water | 9.48 | 8.1 | 8.5 | 357 | 350 | | 8.0 | | <50/<50 | <200/<200 | 5/4 | <200/<200 | <.2/<.2 | | <10/<10 | <5/<5 | 80/<50 | <.2/<.2 | 21/17 | <2/<2 |
| 25-200-SW-07 | 05/01/96 | Duplicate 25-200-SW-07 (05/01/96) | Surface Water | 9.48 | 8.1 | 8.5 | 357 | 347 | | 8.0 | | <50/<50 | <200/<200 | 8/3 | <200/<200 | <.2/<.2 | | <10/<10 | <5/<5 | 90/<50 | <.2/<.2 | 22/16 | <2/<2 |
| 25-200-SW-07 | 08/28/96 | Silver Creek at Goldsil, second culvert | Surface Water | 2.50 | 6.8 | 7.9 | 337 | 385 | | 17.8 | | <50/<50 | <200/<200 | 13/13 | <200/<200 | 4/2 | | <10/<10 | 2/<2 | 310/210 | <.2/<.2 | 68/63 | <2/<2 |
| 25-200-SW-08 | 10/11/95 | Sitzer Gulch at Birdseye Road | Surface Water | 0.13 | 6.5 | 8.2 | 810 | 792 | | 14.0 | | <50/<50 | <200/<200 | 8/3 | <200/<200 | <.2/<.2 | | <10/<10 | 1/<1 | 100/<50 | <.2/<.2 | 73/73 | <2/<2 |
| 25-200-SW-08 | 02/08/96 | Sitzer Gulch at Birdseye Road | Surface Water | 4.50 | 7.5 | 7.4 | 201 | 199 | | 3.0 | | <50/<50 | 3500/<200 | 4/3 | <200/<200 | <.2/<.2 | | <10/<10 | 14/<5 | 3690/130 | <.2/<.2 | 214/68 | 3/<2 |
| 25-200-SW-08 | 05/01/96 | Sitzer Gulch at Birdseye Road | Surface Water | 0.30 | 8.0 | 8.2 | 703 | 726 | | 9.0 | | <50/<50 | <200/<200 | 10/4 | <200/<200 | <.2/<.2 | | <10/<10 | <5/<5 | 120/<50 | <.2/<.2 | 53/46 | <2/<2 |
| 25-200-SW-09 | 10/11/95 | Silver Creek at railroad trestle below Sitzer (continous recorder sta.) | Surface Water | 0.92 | 7.7 | 8.4 | 422 | 424 | | 13.0 | | <50/<50 | <200/<200 | 13/13 | <200/<200 | <.2/<.2 | | <10/<10 | 2/<1 | 90/<50 | <.2/<.2 | <15/<15 | <2/<2 |
| 25-200-SW-09 | 02/08/96 | Silver Creek at railroad trestle below Sitzer (continous recorder sta.) | Surface Water | 65.00 | 7.8 | 7.4 | 202 | 198 | | 4.0 | | <50/<50 | 1500/<200 | 12/9 | <200/<200 | <.2/<.2 | | <10/<10 | 8/<5 | 170/90 | <.2/<.2 | 114/46 | 2/<2 |
| 25-200-SW-09 | 05/01/96 | Silver Creek at railroad trestle below Sitzer (continous recorder sta.) | Surface Water | 9.35 | 8.1 | 8.5 | 393 | 380 | | 12.0 | | <50/<50 | <200/<200 | 9/5 | <200/<200 | <.2/<.2 | | <10/<10 | <5/<5 | 200/<50 | <.2/<.2 | 36/15 | <2/<2 |
| 25-200-SW-09 | 08/28/96 | Silver Creek at railroad trestle below Sitzer (continous recorder sta.) | Surface Water | 2.40 | 7.7 | 8.3 | 366 | 401 | | 20.0 | | <50/<50 | 200/<200 | 25/25 | <200/<200 | <.2/<.2 | | <10/<10 | 2/2 | 430/180 | <.2/<.2 | 77/30 | <2/<2 |
| 25-200-SW-10 | 10/11/95 | Threemile Creek | Surface Water | 0.13 | 7.1 | 8.3 | 432 | 385 | | 13.0 | | <50/<50 | <200/<200 | 24/20 | 200/200 | <.2/<.2 | | <10/<10 | 6/<1 | 80/<50 | <.2/<.2 | <15/<15 | <2/<2 |
| 25-200-SW-10 | 02/08/96 | Threemile Creek | Surface Water | 8.50 | 7.8 | 7.7 | 118 | 102 | | 4.0 | | <50/<50 | 4200/<200 | 14/14 | <200/<200 | <.2/<.2 | | <10/<10 | 8/<5 | 3960/100 | <.2/<.2 | 214/16 | 3/<2 |
| 25-200-SW-10 | 05/01/96 | Threemile Creek | Surface Water | 1.00 | 8.1 | 8.4 | 432 | 366 | | 7.0 | | <50/<50 | 300/<200 | 14/7 | 200/200 | <.2/<.2 | | <10/<10 | <5/<5 | 290/<50 | <.2/<.2 | 39/16 | <2/<2 |
| 25-200-SW-11 | 10/11/95 | Silver Creek at Silver Creek Estates Road | Surface Water | 1.31 | 8.0 | 8.3 | 825 | 776 | | 13.0 | | <50/<50 | <200/<200 | 12/8 | <200/<200 | <.2/<.2 | | <10/<10 | 5/3 | 190/<50 | <.2/<.2 | 82/72 | <2/<2 |
| 25-200-SW-11 | 02/08/96 | Silver Creek at Silver Creek Estates Road | Surface Water | 45.00 | 7.4 | 7.2 | 160 | 178 | | 4.0 | | <50/<50 | 2800/<200 | 8/8 | <200/<200 | .3/.2 | | <10/<10 | 21/<5 | 2930/160 | <.2/<.2 | 3260/136 | 3/<2 |
| 25-200-SW-11 | 02/08/96 | Duplicate 25-200-SW-11 (02/08/96) | Surface Water | 45.00 | 7.4 | 6.9 | 160 | 184 | | 4.0 | | <50/<50 | 3900/<200 | 8/8 | <200/<200 | <.2/<.2 | | <10/<10 | 27/<5 | 3350/140 | <.2/<.2 | 3580/13400 | 3/<2 |
| 25-200-SW-11 | 05/01/96 | Silver Creek at Silver Creek Estates Road | Surface Water | 10.45 | 8.2 | 8.4 | 588 | 594 | | 10.0 | | <50/<50 | 500/<200 | 9/8 | <200/<200 | <.2/<.2 | | <10/<10 | 7/7 | 460/<50 | <.2/<.2 | 80/48 | <2/<2 |
| 25-200-SW-11 | 08/28/96 | Silver Creek at Silver Creek Estates Road | Surface Water | 1.50 | 8.1 | 8.2 | 809 | 925 | | 19.0 | | <50/<50 | 300/<200 | 20/18 | <200/<200 | .5/.2 | | <10/<10 | 8/7 | 390/150 | <.2/<.2 | 167/168 | <2/<2 |
| 25-200-SW-11 | 08/28/96 | Duplicate 25-200-SW-11 (08/28/96) | Surface Water | | | 8.2 | | 925 | | | | <50/<50 | 300/<200 | 20/20 | <200/<200 | <.2/<.2 | | <10/<10 | 10/7 | 390/140 | <.2/<.2 | 166/166 | <2/<2 |
| 25-365-SW-1 | 09/02/93 | Goldsil Millsite - at toe of berm w/flow gate in Silver Crk | Surface Water | | | | | | | | | | | 5.29 | 82.7 | 4.59 | 5 | 6.24 | 2.33 | 123 | 0.12 | 21.8 | 10.9 |
| 25-365-SW-2 | 09/02/93 | Goldsil Millsite - Silver Crk at culvert (downgradient) at rd. | Surface Water | | | | | | | | | | | 4.35 | 73.6 | 4.59 | 5 | 6.24 | 2.33 | 90.8 | 0.12 | 15.3 | 10.9 |
| 25-365-SW-3 | 09/02/93 | Goldsil Millsite - Silver Crk upgradient (200') from Argo mill bldg. | Surface Water | | | | | | | | | | | 2.56 | 68.4 | 4.59 | 5 | 6.24 | 2.33 | 93.3 | 0.12 | 16.9 | 10.9 |
| 25-365-SW-5 | 09/02/93 | Goldsil Millsite - pregnant pond below mill | Surface Water | | | | | | | | | | | | | | | | | | | | |
| 25-024-AD1 | 6/23-24/93 | Drumlummon - Adit discharge on WR4 | Surface Water | | | | | | | | | 0.14 | | 34.9 | 128 | 2.6 | 8.7 | 4.7 | 4.6 | 2140 | 0.11 | 1640 | 8.0 |
| 25-024-SW1 | 6/23-24/93 | Drumlummon - Ottawa Gulch (Silver Crk) upstream of mines and mills | Surface Water | | | | | | | | | 0.12 | | 2.2 | 94 | 2.6 | 8.7 | 4.9 | 4.6 | 44.1 | 0.11 | 8.0 | 9.8 |
| 25-024-SW2 | 6/23-24/93 | Drumlummon - Silver Crk below mines, mills and TP1 | Surface Water | | | | | | | | | 0.12 | | 2.1 | 81.9 | 2.6 | 8.7 | 4.7 | 4.6 | 91.4 | 0.11 | 21.8 | 8.0 |
| 25-024-SW3 | 6/23-24/93 | Drumlummon - Silver Crk below tailings TP2, two miles below mills | Surface Water | | | | | | | | | 0.12 | | 3.6 | 74.4 | 2.6 | 8.7 | 5.9 | 7.3 | 262 | 0.11 | 41.3 | 8.0 |
| SW-1 | 07/08/88 | Goldsil Millsite - Silver Crk 3 mi. west of lower gate | Surface Water | | 8.3 | | 150 | | | 11 | | | | | | | | | | | 0 | | |
| SW-2 | 07/08/88 | Goldsil Millsite - Silver Crk 0.9 mi. west of lower gate | Surface Water | | 8.2 | | 165 | | | 11 | | | | | | | | | | | 0 | | |
| SW-3 | 07/08/88 | Goldsil Millsite - Silver Crk at upstream entrance to site | Surface Water | | 7.9 | | 180 | | | 11 | | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 |
| SW-4 | 07/08/88 | Goldsil Millsite - Silver Crk N.E. corner of upper lagoon | Surface Water | | | | | | | | | | | | | | | | | | 0 | | |
| SW-5 | 07/08/88 | Goldsil Millsite - Silver Crk at downstream entrance to site | Surface Water | | 8.3 | | 200 | | | 12 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 25 | 0 |
| SW-6 | 07/08/88 | Goldsil Millsite - Silver Crk just below lower lagoon | Surface Water | | 7.3 | | 255 | | | 19 | | | | | | | | | | | 0 | | |

**Table 3-11. Summary of Silver Creek Drainage Surface Water Chemistry Results**

| Sample Station | Sample Date | Sample Location | Medium | Discharge (cfs) | Field pH (s.u.) | Lab pH (s.u.) | Field Specific Conductivity (umhos/cm) | Lab Specific Conductivity (umhos/cm) | Lab Turbidity (JTU) | Water Temp (C) | Oxidation Reduction Potential (mv) | Ag (ug/L) Total/Dissolved | Al (ug/L) Total/Dissolved | As (ug/L) Total/Dissolved | Ba (ug/L) Total/Dissolved | Cd (ug/L) Total/Dissolved | Co (ug/L) | Cr (ug/L) Total/Dissolved | Cu (ug/L) Total/Dissolved | Fe (ug/L) Total/Dissolved | Hg (ug/L) Total/Dissolved | Mn (ug/L) Total/Dissolved | Ni (ug/L) Total/Dissolved |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | WQB-7-Human Health Standard | Surface Water | | | | | | | | | 100 | | 18 | 2000 | 5 | | 100 | 1300 | 300 | 0.05 | 50 | 100 |
| | | WQB-7 Acute Aquatic Life Standard | Surface Water | | | | | | | | | 13.4* | 750 | 340 | | 4.3* | | NA** | 26.9* | | 1.7 | | 843.3* |
| | | WQB-7 Chronic Aquatic Life Standard | Surface Water | | | | | | | | | | 87 | 150 | | 0.45* | | NA** | 16.9* | 1000 | 0.91 | | 93.8* |
| SW-7 | 07/08/88 | Goldsil Millsite - Silver Crk just below Buck Lake | Surface Water | | 7.3 | | 200 | | | 16 | | | | | | | | | | | 0 | | |
| LL-1 | 07/08/88 | Goldsil Millsite - spring below the lower lagoon | Surface Water | | 7.7 | | 310 | | | 15 | | 0 | 0 | 0 | | 7 | 0 | 0 | 0 | 358 | 1.1 | 90 | 0 |
| ML-1 | 07/08/88 | Goldsil Millsite - lagoon just north of mill | Surface Water | | | | | | | | | 0 | 0 | 74.5 | 0 | 0 | 0 | 19 | 35 | 294 | 9.8 | 19 | 0 |
| UL-1 | 07/08/88 | Goldsil Millsite - lagoon upstream from mill | Surface Water | | | | | | | | | 269 | 3330 | 21.5 | 0 | 10 | 0 | 16 | 1160 | 6070 | 89 | 504 | 40 |
| H7 | 12/07/81 | Silver Crk - above Maskelyne Tunnel; above mine office entrance road | Surface Water | 0.66 | | 7.4 | | 245 | 2.3 | | | <5/<5 | 1700/<100 | <5/<5 | <100/<100 | <1/<1 | | <20/<20 | 10/10 | 100/30 | <1/<1 | 30/20 | |
| H7 | 06/10/82 | Silver Crk - above Maskelyne Tunnel; above mine office entrance road | Surface Water | 5.35 | | | | | | | | | | | | | | | <10 | | <0.2 | | |
| H7 | 10/25/82 | Silver Crk - above Maskelyne Tunnel; above mine office entrance road | Surface Water | 0.88 | | | | 250 | 1.3 | | | | | | | | | | <10/<10 | | <1/<1 | | |
| H7 | 12/14/83 | Silver Crk - above Maskelyne Tunnel; above mine office entrance road | Surface Water | 0.52 | | | | | 2 (Est.) | | | | | | | | | | | | | | |
| H9 | 10/21/81 | Ottawa Gulch just above Obie Adit | Surface Water | 0.65 | | 7.8 | 235 | 230 | 3.7 | 1.2 | | <5/<5 | 100/<100 | <5/<5 | <100/<100 | 2/<1 | | <20/<20 | 10/<10 | 150/<30 | 0.2/0.2 | <20/<20 | |
| H11 | 12/14/83 | Jennies Fork; at county road bridge | Surface Water | 0.048 | | | | | | 2 (Est.) | | | | | | | | | | | | | |
| H12 | 12/14/83 | Silver Creek; below Jennies Fork | Surface Water | 0.65 | | | | | 2 (Est.) | | | | | | | | | | | | | | |
| H13 | 12/14/83 | Silver Creek above Sawmill Gulch | Surface Water | 0.79 | | | | | 2 (Est.) | | | | | | | | | | | | | | |
| H14 | 12/14/83 | Sawmill Gulch above Silver Creek | Surface Water | 0.5 (Est.) | | | | | 2 (Est.) | | | | | | | | | | | | | | |
| FG1/H15 | 10/21/76 | Silver Creek; below China Gulch | Surface Water | | | | | 348 | | | | 10 | | | | | | | <10 | | <0.2 | | |
| FG1/H15 | 11/15/74 | Silver Creek; below China Gulch | Surface Water | | | | | | | | | | | | | | | | | | | | |
| FG1/H15 | 11/29/76 | Silver Creek; below China Gulch | Surface Water | | | | | | | | | | | | | | | | | | | | |
| FG1/H16 | 10/21/76 | Silver Creek; below China Gulch | Surface Water | | | | | 414 | | | | 10 | | | | | | | <10 | | <0.2 | | |
| H17 | 11/23/74 | Silver Creek above China Gulch | Surface Water | | | | 384 | | | 4.3 | | | | | | | | | | | | | |
| H18 | 11/23/76 | Silver Creek above China Gulch | Surface Water | | | | 357 | | | 3.6 | | | | | | | | | | | | | |
| H19 | 11/23/76 | Silver Creek above China Gulch | Surface Water | | | | 297 | | | 3.4 | | | | | | | | | | | | | |
| H20 | 11/23/76 | China Gulch above Silver Creek | Surface Water | | | | 371 | | | 3.0 | | | | | | | | | | | | | |
| H21 | 11/23/76 | Silver Creek; below China Gulch | Surface Water | | | | 321 | | | 3.3 | | | | | | | | | | | | | |
| H22 | 11/23/76 | Silver Creek above tailings | Surface Water | | | | 299 | | | 2.0 | | | | | | | | | | | | | |
| H23 | 11/23/76 | Silver Creek above tailings | Surface Water | | | | 333 | | | 3 | | | | | | | | | | | | | |
| H24 | 11/23/76 | Silver Creek at Mill | Surface Water | | | | 365 | | | 4.7 | | | | | | | | | | | | | |
| H25 | 11/23/76 | Silver Creek below Mill | Surface Water | | | | 365 | | | 4.5 | | | | | | | | | | | | | |
| H26 | 11/23/76 | Silver Creek near Clear Pond | Surface Water | | | | 373 | | | 3.9 | | | | | | | | | | | | | |
| H27 | 11/23/76 | Silver Creek above gravel road | Surface Water | | | | 383 | | | 3 | | | | | | | | | | | | | |
| H28 | 11/23/76 | Silver Creek above Sitzer | Surface Water | | | | 393 | | | 2.1 | | | | | | | | | | | | | |
| WQ1/H6 | 09/17/80 | Silver Crk - above Goldsil; at culvert at mill office entrance road | Surface Water | | 8.3 | 8.12 | | 362 | | | | <10/<10 | | 5/5 | | <5/<5 | | | <10/<10 | 80/30 | <.2/<.2 | | |
| WQ1/H6 | 10/23/80 | Silver Crk - above Goldsil; at culvert at mill office entrance road | Surface Water | | | 8.43 | | 372 | | | | <10 | | | | | | | <10 | 30 | <.2 | | |
| WQ1/H6 | 10/28/80 | Silver Crk - above Goldsil; at culvert at mill office entrance road | Surface Water | | | 8.48 | | 345 | | | | <10 | | | | | | | 70 | 70 | <.2 | | |
| WQ1/H6 | 10/29/80 | Silver Crk - above Goldsil; at culvert at mill office entrance road | Surface Water | 0.86 | | | | 330 | | | | <1 | | | | | | | 30 | | <1 | | |
| WQ1/H6 | 10/30/80 | Silver Crk - above Goldsil; at culvert at mill office entrance road | Surface Water | | | | | | | | | | | | | | | | | | | | |
| WQ1/H6 | 12/10/80 | Silver Crk - above Goldsil; at culvert at mill office entrance road | Surface Water | | | 7.75 | | | | | | <10 | | | | | | | <10 | | <.2 | | |
| WQ1/H6 | 06/30/81 | Silver Crk - above Goldsil; at culvert at mill office entrance road | Surface Water | 6.34 | | | | 340 | 2.0 | | | | | | | | | | | | <.2 | | |
| WQ2/H5 | 10/09/80 | Silver Crk - at entrance to Goldsil mill | Surface Water | | | 8.05 | | 414 | | | | <10 | | | | | | | <10 | | <.2 | | |
| WQ2/H5 | 10/15/80 | Silver Crk - at entrance to Goldsil mill | Surface Water | | | 8.08 | | 385 | | | | <10 | | | | | | | <10 | | <.2 | | |
| WQ2/H5 | 10/23/80 | Silver Crk - at entrance to Goldsil mill | Surface Water | | | 8.23 | | 449 | | | | <10 | | | | | | | <10 | <0.13 | <.2 | | |
| WQ2/H5 | 10/28/80 | Silver Crk - at entrance to Goldsil mill | Surface Water | | | 8.22 | | 405 | | | | <10 | | | | | | | <10 | 70 | <.2 | | |
| WQ2/H5 | 10/29/80 | Silver Crk - at entrance to Goldsil mill | Surface Water | 2.12 | | | | 400 | | | | <1 | | | | | | | 30 | | <1 | | |
| WQ2/H5 | 06/30/81 | Silver Crk - at entrance to Goldsil mill | Surface Water | 9.40 | | | | 350 | 1.2 | | | | | | | | | | | | 0.4 | | |
| WQ2/H5 | 06/10/82 | Silver Crk - at entrance to Goldsil mill | Surface Water | | | | | | | | | | | | | | | | | | <.2 | | |
| WQ2/H5 | 10/25/82 | Silver Crk - at entrance to Goldsil mill | Surface Water | 2.19 | | | | 393 | 1.4 | | | | | | | | | | | | <1/<1 | | |
| WQ2/H5 | 11/16/83 | Silver Crk - at entrance to Goldsil mill | Surface Water | | | | | | | | | | | | | | | | | | | | |
| WQ12/H4 | 10/09/80 | Silver Crk - above Upper Pond | Surface Water | | | 7.93 | | 414 | | | | <10 | | | | | | | <10 | | <.2 | | |
| WQ12/H4 | 10/15/80 | Silver Crk - above Upper Pond | Surface Water | | | 8.20 | | 393 | | | | <10 | | | | | | | <10 | | <.2 | | |
| WQ12/H4 | 10/29/80 | Silver Crk - above Upper Pond | Surface Water | 2.32 | | | | 400 | | | | <10 | | | | | | | 20 | | <1 | | |
| WQ12/H4 | 06/30/81 | Silver Crk - above Upper Pond | Surface Water | 8.05 | | | | 350 | 1.4 | | | | | | | | | | | | 0.3 | | |
| WQ10 | 10/28/80 | Silver Crk - between Upper & Lower Ponds | Surface Water | | | 8.32 | | 441 | | | | <10 | | | | | | | 10 | 120 | <.2 | | |
| WQ3/H3 | 10/09/80 | Silver Crk - above seep; opposite White's tailings pond | Surface Water | | | 8.33 | | 426 | | | | 10 | | | | | | | 20 | | 9 | | |
| WQ3/H3 | 10/15/80 | Silver Crk - above seep; opposite White's tailings pond | Surface Water | | | 8.32 | | 408 | | | | <10 | | | | | | | <10 | | 4 | | |
| WQ3/H3 | 10/23/80 | Silver Crk - above seep; opposite White's tailings pond | Surface Water | | | 8.42 | | 484 | | | | 10 | | | | | | | <10 | 130 | 0.8 | | |
| WQ3/H3 | 10/28/80 | Silver Crk - above seep; opposite White's tailings pond | Surface Water | | | 8.33 | | 431 | | | | <10 | | | | | | | <10 | 0.11 | <.2 | | |
| WQ3/H3 | 12/10/80 | Silver Crk - above seep; opposite White's tailings pond | Surface Water | | 7.10 | | | | | | | <10 | | | | | | | <10 | | <.2 | | |
| WQ5 | 10/09/80 | Silver Crk - below seep | Surface Water | | | 8.27 | | 438 | | | | 20 | | | | | | | 40 | | 10 | | |
| WQ5 | 10/15/80 | Silver Crk - below seep | Surface Water | | | 8.30 | | 395 | | | | 10 | | | | | | | 20 | | 12 | | |
| WQ5 | 10/23/80 | Silver Crk - below seep | Surface Water | | | 8.34 | | 512 | | | | 10 | | | | | | | 10 | 180 | 12 | | |
| WQ5 | 10/28/80 | Silver Crk - below seep | Surface Water | | | 8.40 | | 447 | | | | <10 | | | | | | | 10 | 110 | 3 | | |
| WQ5 | 12/10/80 | Silver Crk - below seep | Surface Water | | | 8.16 | | | | | | <10 | | | | | | | 10 | | 0.2 | | |

**Table 3-11. Summary of Silver Creek Drainage Surface Water Chemistry Results**

| Sample Station | Sample Date | Sample Location | Medium | Discharge (cfs) | Field pH (s.u.) | Lab pH (s.u.) | Field Specific Conductivity (umhos/cm) | Lab Specific Conductivity (umhos/cm) | Lab Turbidity (JTU) | Water Temp (C) | Oxidation Reduction Potential (mv) | Ag (ug/L) Total/Dissolved | Al (ug/L) Total/Dissolved | As (ug/L) Total/Dissolved | Ba (ug/L) Total/Dissolved | Cd (ug/L) Total/Dissolved | Co (ug/L) | Cr (ug/L) Total/Dissolved | Cu (ug/L) Total/Dissolved | Fe (ug/L) Total/Dissolved | Hg (ug/L) Total/Dissolved | Mn (ug/L) Total/Dissolved | Ni (ug/L) Total/Dissolved |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | WQB-7-Human Health Standard | Surface Water | | | | | | | | | 100 | | 18 | 2000 | 5 | | 100 | 1300 | 300 | 0.05 | 50 | 100 |
| | | WQB-7 Acute Aquatic Life Standard | Surface Water | | | | | | | | | 13.4* | 750 | 340 | | 4.3* | | NA** | 26.9* | | 1.7 | | 843.3* |
| | | WQB-7 Chronic Aquatic Life Standard | Surface Water | | | | | | | | | | 87 | 150 | | 0.45* | | NA** | 16.9* | 1000 | 0.91 | | 93.8* |
| WQ6/H2 | 11/15/76 | Silver Crk - below seep | Surface Water | | | | | | | | | | | | | | | | | | | | |
| WQ6/H2 | 11/29/76 | Silver Crk - below seep | Surface Water | | | | | | | | | | | | | | | | | | | | |
| WQ6/H2 | 09/17/80 | Silver Crk - above Buck Lake | Surface Water | | 8.4 | 8.34 | | 420 | | | | <20/<10 | | 6/6 | | <5/<5 | | | 60/70 | 90/50 | 7/7 | | |
| WQ6/H2 | 10/09/80 | Silver Crk - above Buck Lake | Surface Water | | | 8.34 | | 429 | | | | 10 | | | | | | | 30 | | 9 | | |
| WQ6/H2 | 10/15/80 | Silver Crk - above Buck Lake | Surface Water | | | 8.29 | | 423 | | | | <10 | | | | | | | 20 | | 8 | | |
| WQ6/H2 | 10/23/80 | Silver Crk - above Buck Lake | Surface Water | | | 8.33 | | 516 | | | | 10 | | | | | | | 10 | 180 | 6 | | |
| WQ6/H2 | 10/28/80 | Silver Crk - above Buck Lake | Surface Water | | | 8.29 | | 448 | | | | <10 | | | | | | | 10 | 110 | 2 | | |
| WQ6/H2 | 10/29/80 | Silver Crk - above Buck Lake | Surface Water | 2.78 | | | | 410 | | | | 2 | | | | | | | 30 | | 9.1 | | |
| WQ6/H2 | 06/30/81 | Silver Crk - above Buck Lake | Surface Water | 8.14 | | | | 355 | 2.4 | | | | | | | | | | | | 0.3 | | |
| WQ6/H2 | 06/21/82 | Silver Crk - above Buck Lake | Surface Water | | | | | | | | | | | | | | | | | | | | |
| WQ6/H2 | 10/25/82 | Silver Crk - above Buck Lake | Surface Water | 2.14 | | | | 396 | 4.8 | | | | | | | | | | | | <1/<1 | | |
| WQ4/H1 | 09/17/80 | Silver Crk - seep | Surface Water | | 7.9 | 7.76 | | 762 | | | | 120/420 | | 2/2 | | 5/5 | | | 5500/5500 | 130/100 | 850/840 | | |
| WQ4/H1 | 10/23/80 | Silver Crk - seep | Surface Water | | | 7.56 | | 791 | | | | 800 | | | | | | | 1000 | 40 | 800 | | |
| WQ4/H1 | 10/28/80 | Silver Crk - seep | Surface Water | | | 7.56 | | 759 | | | | 90 | | | | | | | 710 | 110 | 800 | | |
| WQ4/H1 | 10/29/80 | Silver Crk - seep | Surface Water | 0.009 | | | | 690 | | | | 32 | | | | | | | 500 | | 1030 | | |
| WQ4/H1 | 10/29/80 | Silver Crk - seep | Surface Water | 0.009 | | | | | | | | | | | | | | | | | | | |
| WQ4/H1 | 12/10/80 | Silver Crk - seep | Surface Water | | | 7.64 | | | | | | 20 | | | | | | | 30 | | 200 | | |
| WQ4/H1 | 06/30/81 | Silver Crk - seep | Surface Water | 0.003 | | | | 640 | 0.55 | | | | | | | | | | | | 38 | | |
| WQ4/H1 | 06/30/81 | Silver Crk - seep | Surface Water | 0.003 | | | | 640 | 0.62 | | | | | | | | | | | | 42 | | |
| WQ4/H1 | 06/21/82 | Silver Crk - seep | Surface Water | | | | | | | | | | | | | | | | | | | | |
| WQ4/H1 | 10/25/82 | Silver Crk - seep | Surface Water | | | | | 605 | 1.3 | | | | | | | | | | | | 8/8 | | |
| WQ4/H1 | 10/25/82 | Silver Crk - seep | Surface Water | 2.14 | | | | 396 | 4.8 | | | | | | | | | | | | 1/1 | | |
| WQ7 | 10/09/80 | Silver Crk - below Buck Lake | Surface Water | | | 8.05 | | 400 | | | | 10 | | | | | | | 30 | | 1.6 | | |
| WQ7 | 10/23/80 | Silver Crk - below Buck Lake | Surface Water | | | 8.14 | | 486 | | | | 10 | | | | | | | 10 | 80 | 4 | | |
| WQ7 | 10/28/80 | Silver Crk - below Buck Lake | Surface Water | | | 8.18 | | 457 | | | | <10 | | | | | | | 10 | 80 | 2 | | |
| WQ7 | 12/10/80 | Silver Crk - below Buck Lake | Surface Water | | | 7.94 | | | | | | <10 | | | | | | | 10 | | <.2 | | |
| WQ8 | 10/23/80 | Goldsil - Upper Holding Pond (clear water) | Surface Water | | | 8.45 | | 438 | | | | <10 | | | | | | | <10 | 210 | <.2 | | |
| WQ8 | 10/28/80 | Goldsil - Upper Holding Pond (clear water) | Surface Water | | | 8.33 | | 414 | | | | <10 | | | | | | | 10 | 190 | <.2 | | |
| WQ9 | 10/23/80 | Goldsil - Lower Tailings Pond | Surface Water | | | 8.66 | | 415 | | | | 20 | | | | | | | 240 | 340 | 80 | | |
| WQ9 | 10/28/80 | Goldsil - Lower Tailings Pond | Surface Water | | | 8.50 | | 398 | | | | 40 | | | | | | | 270 | 240 | 120 | | |
| WQ10 | 10/28/80 | Silver Crk - below Clear Pond | Surface Water | | | 8.32 | | 441 | | | | <10 | | | | | | | 10 | 120 | <.2 | | |
| WQ11 | 12/10/80 | Silver Crk - Birdseye Road | Surface Water | | | 7.90 | | | | | | <10 | | | | | | | <10 | | <.2 | | |
| Sawmill C | 11/20/80 | Sawmill Crk | Surface Water | 2.0 | 6.3 | 8.43 | 340 | 415 | | 1 | | | | | | | | | | 60 | | 10 | |
| Sawmill C | 09/19/81 | Sawmill Crk | Surface Water | 1.0 | 6.2 | 7.00 | 340 | 390.6 | | 3 | | | | | | | | | 9 | | | 8 | |
| Ottawa C | 12/78 | Ottawa Crk | Surface Water | | | | | | | | | | | | | | | | | <10 | | <10 | |
| Ottawa C | 01/30/79 | Ottawa Crk | Surface Water | | | | | | | | | | | | | | | | | <10 | | <10 | |
| Station #1 | 10/21/76 | Silver Creek below China Gulch | Surface Water | | | | | 348 | | | | 10 | | | | | | | <10 | | <.2 | | |
| Station #1 | 11/15/76 | Silver Creek below China Gulch | Surface Water | | | | | | | | | | | | | | | | | | | | |
| Station #1 | 11/29/76 | Silver Creek below China Gulch | Surface Water | | | | | | | | | | | | | | | | | | | | |
| Station #1 | 01/12/77 | Silver Creek below China Gulch | Surface Water | | | | | | | | | | | | | <1 | | | <10 | 90 | | | <50 |
| Station #1 | 01/31/77 | Silver Creek below China Gulch | Surface Water | | | | | | | | | | | | | | | | | | | | |
| Station #1A | 01/31/77 | Silver Creek near Goldsil tailings pile | Surface Water | | | | | | | | | | | | | | | | | | | | |
| Station #2A | 01/12/77 | Pond between mill and no trespassing access road east of mill | Surface Water | | | | | | | | | | | | | <1 | | | <10 | 320 | | | <50 |
| Station #2B | 01/12/77 | Silver Creek between mill and upper tailings pond at headgate | Surface Water | | | | | | | | | | | | | <1 | | | <10 | 250 | | | <50 |
| Station #3 | 10/21/76 | Upper tailings pond | Surface Water | | | | | 1191 | | | | 410 | | | | | | | 8000 | | 140 | | |
| Station #3 | 11/15/76 | Upper tailings pond | Surface Water | | | | | | | | | | | | | | | | | | | | |
| Station #3 | 01/12/77 | Upper tailings pond | Surface Water | | | | | | | | | | | | | <1 | | | 28000 | 20 | | | 90 |
| Station #6 | 11/15/76 | Silver Creek below lower tailings pond | Surface Water | | | | | | | | | | | | | | | | | | | | |
| Station #6 | 11/29/76 | Silver Creek below lower tailings pond | Surface Water | | | | | | | | | | | | | | | | | | | | |
| Station #6 | 01/12/77 | Silver Creek below lower tailings pond | Surface Water | | | | | | | | | | | | | <1 | | | 10 | 100 | | | <50 |
| Station #6 | 01/31/77 | Silver Creek below lower tailings pond | Surface Water | | | | | | | | | | | | | | | | | | | | |
| Station #7 | 10/21/76 | Silver Creek at gravel road 0.9 mile from Lincoln highway | Surface Water | | | | | 414 | | | | 10 | | | | | | | <10 | | <.2 | | |

Note: WQB-7 standards for metals (except aluminum) in surface water are based upon the analysis of total recoverable metals.
Aluminum is based on dissolved metals.

*Based on a hardness of 200 mg/l as $CaCO_3$ (note that average hardness for previous data is 190 mg/l $CaCO_3$)

**Aquatic life standards are based on specization of Cr(III) and Cr(VI). The analyses performed were total Cr.

**Table 3-11. Summary of Silver Creek Drainage Surface Water Chemistry Results**

| Sample Station | Sample Date | Sample Location | Medium | Pb (ug/L) Total/Dissolved | Sb (ug/L) Total/Dissolved | Se (ug/L) Total/Dissolved | Zn (ug/L) Total/Dissolved | Ca (mg/L) | Mg (mg/L) | Na (mg/L) | K (mg/L) | Hardness (mg $CaCO_3$/L) | Total Suspended Solids (mg/L) | Total Dissolved Solids (mg/L) | Carbonate as $CO_3$ (mg/L) | Bicarbonate as $HCO_3$ (mg/L) | Total Alkalinity as $CaCO_3$ (mg/L) | Chloride (mg/L) | Sulfate (mg/L) | $NO_3/NO_2$-N (mg/L) | Total Cyanide (mg/L) | Source/Date |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | WQB-7-Human Health Standard | Surface Water | 15 | 6 | 50 | 2000 | | | | | | | | | | | | | 10000 | 200 | |
| | | WQB-7 Acute Aquatic Life Standard | Surface Water | 197.3* | | 20 | 215.6* | | | | | | | | | | | | | | 22 | |
| | | WQB-7 Chronic Aquatic Life Standard | Surface Water | 7.7* | | 5 | 215.6* | | | | | | | | | | | | | | 5.2 | |
| Culvert Intake | 03/27/02 | Silver Crk Ranchette Rd. | Surface Water | <10/ | <50/ | | 20/ | | | | | | | | | | | | | | | DEQ/MWCB, 2002 |
| Transfer Station Rd | 03/27/02 | Silver Crk - at Transfer Station Rd. | Surface Water | <10/ | <50/ | | <10/ | | | | | | | | | | | | | | | DEQ/MWCB, 2002 |
| 25-200-SW-01 | 10/11/95 | Rawhide Gulch at Ski road | Surface Water | <1/<1 | | <5/<5 | <20/<20 | 29.0 | 3.0 | 1.0 | 1.0 | 85 | | 111 | 0 | 98 | 80 | 2 | 10 | 0.08 | 0.005 | Maxim, 1996 |
| 25-200-SW-01 | 02/08/96 | Rawhide Gulch at Ski road | Surface Water | <1/<1 | | <5/<5 | 40/30 | 28.0 | 4.0 | 1.0 | 1.0 | 86 | | 118 | 0 | 104 | 85 | 2 | 10 | 0.13 | | Maxim, 1996 |
| 25-200-SW-01 | 05/01/96 | Rawhide Gulch at Ski road | Surface Water | 1/<1 | | <5/<5 | <20/<20 | 26.0 | 3.0 | 1.0 | 1.0 | 77 | | 115 | 0 | 95 | 78 | 1 | 9 | 0.16 | 0.005 | Maxim, 1996 |
| 25-200-SW-01 | 08/28/96 | Rawhide Gulch at Ski road | Surface Water | 40/30 | | <5/<5 | 30/30 | 27.0 | 4.0 | 1.0 | 1.0 | 84 | | 126 | 0 | 92 | 75 | 1 | 10 | 0.05 | 0.005 | Maxim, 1996 |
| 25-200-SW-02 | 10/11/95 | Silver Creek at Marysville | Surface Water | 2/<1 | | <5/<5 | <20/30 | 38.0 | 4.0 | 1.0 | 1.0 | 111 | | 195 | 0 | 135 | 111 | 1 | 10 | 0.20 | 0.005 | Maxim, 1996 |
| 25-200-SW-02 | 02/08/96 | Silver Creek at Marysville | Surface Water | 3/<1 | | <5/<5 | 20/<20 | 40.0 | 4.0 | 1.0 | 2.0 | 116 | | 136 | 0 | 121 | 99 | 3 | 13 | 0.33 | 0.005 | Maxim, 1996 |
| 25-200-SW-02 | 05/01/96 | Silver Creek at Marysville | Surface Water | 4/<1 | | <5/<5 | <20/<20 | 42.0 | 3.0 | 1.0 | 2.0 | 117 | | 139 | 0 | 135 | 111 | 2 | 11 | 0.26 | 0.005 | Maxim, 1996 |
| 25-200-SW-02 | 08/28/96 | Silver Creek at Marysville | Surface Water | 9/4 | | <5/<5 | 30/<20 | 44.0 | 5.0 | 1.0 | 2.0 | 130 | | 163 | 0 | 149 | 122 | 1 | 10 | 0.27 | 0.005 | Maxim, 1996 |
| 25-200-SW-02A | 08/28/96 | Silver Creek immediately below Drumlummon waste rock pile | Surface Water | 7/5 | | <5/<5 | 100/30 | 44.0 | 6.0 | 1.0 | 2.0 | 135 | | 159 | 0 | 149 | 122 | 1 | 10 | 0.29 | 0.005 | Maxim, 1996 |
| 25-200-SW-03 | 10/11/95 | Jennies Fork; at County Road | Surface Water | <1/<1 | | <5/<5 | 30/<20 | 48.0 | 6.0 | 10.0 | 1.0 | 145 | | 186 | 0 | 159 | 130 | 2 | 21 | 0.88 | 0.005 | Maxim, 1996 |
| 25-200-SW-03 | 02/08/96 | Jennies Fork; at County Road | Surface Water | 2/<1 | | <5/<5 | 20/<20 | 46.0 | 8.0 | 3.0 | 2.0 | 148 | | 171 | 0 | 144 | 118 | 3 | 22 | 0.70 | 0.005 | Maxim, 1996 |
| 25-200-SW-03 | 05/01/96 | Jennies Fork; at County Road | Surface Water | 4/<1 | | <5/<5 | <20/<20 | 41.0 | 7.0 | 1.0 | 2.0 | 131 | | 182 | 0 | 144 | 118 | 3 | 20 | 0.72 | 0.005 | Maxim, 1996 |
| 25-200-SW-04 | 10/11/95 | Silver Creek at Skid Road (continuous recorder station) | Surface Water | 1/<1 | | <5/<5 | 30/<20 | 52.0 | 5.0 | 1.0 | 1.0 | 150 | | 193 | 0 | 153 | 125 | 3 | 18 | 0.43 | 0.005 | Maxim, 1996 |
| 25-200-SW-04 | 02/08/96 | Silver Creek at Skid Road (continuous recorder station) | Surface Water | 18/<1 | | <5/<5 | 70/<20 | 35.0 | 6.0 | 1.0 | 2.0 | 112 | | 88 | 0 | 110 | 90 | 5 | 17 | 0.33 | | Maxim, 1996 |
| 25-200-SW-04 | 05/01/96 | Silver Creek at Skid Road (continuous recorder station) | Surface Water | 6/<1 | | <5/<5 | <20/<20 | 45.0 | 4.0 | 1.0 | 2.0 | 129 | | 161 | 0 | 144 | 118 | 1 | 17 | 0.5 | 0.005 | Maxim, 1996 |
| 25-200-SW-04 | 08/28/96 | Silver Creek at Skid Road (continuous recorder station) | Surface Water | 4/2 | | <5/<5 | 90/40 | 48.0 | 6.0 | 1.0 | 2.0 | 145 | | 179 | 0 | 154 | 126 | 1 | 15 | 0.49 | 0.005 | Maxim, 1996 |
| 25-200-SW-05 | 10/11/95 | Sawmill Gulch | Surface Water | 2/<1 | | <5/<5 | 30/90 | 53.0 | 13.0 | 1.0 | 1.0 | 186 | | 228 | 0 | 225 | 184 | 1 | 18 | 0.05 | 0.005 | Maxim, 1996 |
| 25-200-SW-05 | 02/08/96 | Sawmill Gulch | Surface Water | <1/<1 | | <5/<5 | 20/<20 | 44.0 | 13.0 | 1.0 | 2.0 | 163 | | 145 | 0 | 167 | 137 | 1 | 16 | 0.19 | | Maxim, 1996 |
| 25-200-SW-05 | 05/01/96 | Sawmill Gulch | Surface Water | 2/<1 | | <5/<5 | <20/<20 | 55.0 | 14.0 | 1.0 | 2.0 | 195 | | 225 | 6 | 213 | 184 | 1 | 17 | 0.18 | 0.005 | Maxim, 1996 |
| 25-200-SW-06 | 10/11/95 | Silver Creek immediately above reclaimed tailings channel | Surface Water | 5/<1 | | <5/<5 | <20/<20 | 50.0 | 8.0 | 9.0 | 2.0 | 158 | | 192 | 0 | 187 | 153 | 2 | 16 | 0.20 | 0.005 | Maxim, 1996 |
| 25-200-SW-06 | 02/08/96 | Silver Creek immediately above reclaimed tailings channel | Surface Water | 3/1 | | <5/<5 | 130/<20 | 45.0 | 8.0 | 1.0 | 2.0 | 145 | | 108 | 0 | 161 | 132 | 1 | 16 | 0.47 | | Maxim, 1996 |
| 25-200-SW-06 | 05/01/96 | Silver Creek immediately above reclaimed tailings channel | Surface Water | 3/<1 | | <5/<5 | <20/<20 | 52.0 | 9.0 | 1.0 | 2.0 | 167 | | 207 | 0 | 184 | 151 | 2 | 18 | 0.29 | 0.005 | Maxim, 1996 |
| 25-200-SW-06 | 08/28/96 | Silver Creek immediately above reclaimed tailings channel | Surface Water | 2/<2 | | <5/<5 | 20/<20 | 53.0 | 9.0 | 1.0 | 2.0 | 169 | | 199 | 0 | 188 | 154 | 1 | 16 | 0.26 | 0.005 | Maxim, 1996 |
| 25-200-SW-07 | 10/11/95 | Silver Creek at Goldsil, second culvert | Surface Water | 1/<1 | | <5/<5 | 80/<20 | 64.0 | 13.0 | 1.0 | 2.0 | 213 | | 250 | 0 | 250 | 205 | 3 | 15 | 0.01 | 0.005 | Maxim, 1996 |
| 25-200-SW-07 | 10/11/95 | Duplicate 25-200-SW-07 (10/11/95) | Surface Water | <1/<1 | | <5/<5 | <20/30 | 64.0 | 14.0 | 1.0 | 2.0 | 217 | | 262 | 0 | 254 | 208 | 3 | 15 | 0.01 | 0.005 | Maxim, 1996 |
| 25-200-SW-07 | 02/08/96 | Silver Creek at Goldsil, second culvert | Surface Water | 2/<1 | | <5/<5 | 70/<20 | 44.0 | 9.0 | 1.0 | 3.0 | 147 | | 161 | 0 | 161 | 132 | 3 | 14 | 0.15 | 0.005 | Maxim, 1996 |
| 25-200-SW-07 | 05/01/96 | Silver Creek at Goldsil, second culvert | Surface Water | 1/<1 | | <5/<5 | <20/<20 | 49.0 | 12.0 | 1.0 | 2.0 | 172 | | 216 | 6 | 190 | 165 | 1 | 18 | 0.10 | 0.005 | Maxim, 1996 |
| 25-200-SW-07 | 05/01/96 | Duplicate 25-200-SW-07 (05/01/96) | Surface Water | <1/<1 | | <5/<5 | <20/<20 | 54.0 | 11.0 | 1.0 | 2.0 | 180 | | 209 | 6 | 201 | 165 | 2 | 18 | 0.11 | 0.005 | Maxim, 1996 |
| 25-200-SW-07 | 08/28/96 | Silver Creek at Goldsil, second culvert | Surface Water | 3/<1 | | <5/<5 | 40/40 | 59.0 | 13.0 | 1.0 | 2.0 | 201 | | 230 | 0 | 234 | 192 | 1 | 14 | 0.06 | 0.005 | Maxim, 1996 |
| 25-200-SW-08 | 10/11/95 | Sitzer Gulch at Birdseye Road | Surface Water | <1/<1 | | <5/<5 | <20/<20 | 90.0 | 40.0 | 30.0 | 3.0 | 389 | | 552 | 0 | 345 | 283 | 9 | 142 | 0.01 | 0.007 | Maxim, 1996 |
| 25-200-SW-08 | 02/08/96 | Sitzer Gulch at Birdseye Road | Surface Water | 3/<1 | | <5/<5 | 80/<20 | 20.0 | 8.0 | 1.0 | 8.0 | 83 | | 67 | 0 | 81 | 66 | 2 | 33 | 0.16 | 0.005 | Maxim, 1996 |
| 25-200-SW-08 | 05/01/96 | Sitzer Gulch at Birdseye Road | Surface Water | <1/<1 | | <5/<5 | <20/<20 | 75.0 | 36.0 | 16.0 | 4.0 | 336 | | 462 | 0 | 305 | 250 | 9 | 128 | 0.06 | 0.005 | Maxim, 1996 |
| 25-200-SW-09 | 10/11/95 | Silver Creek at railroad trestle below Sitzer (continous recorder sta.) | Surface Water | <1/<1 | | <5/<5 | 110/<20 | 64.0 | 18.0 | 4.0 | 2.0 | 234 | | 279 | 0 | 259 | 212 | 3 | 31 | 0.01 | 0.005 | Maxim, 1996 |
| 25-200-SW-09 | 02/08/96 | Silver Creek at railroad trestle below Sitzer (continous recorder sta.) | Surface Water | 1/<1 | | <5/<5 | 60/<20 | 21.0 | 8.0 | 1.0 | 6.0 | 85 | | 102 | 0 | 81 | 66 | 3 | 24 | 0.09 | | Maxim, 1996 |
| 25-200-SW-09 | 05/01/96 | Silver Creek at railroad trestle below Sitzer (continous recorder sta.) | Surface Water | <1/<1 | | <5/<5 | <20/<20 | 51.0 | 18.0 | 1.0 | 3.0 | 201 | | 244 | 6 | 213 | 184 | 2 | 27 | 0.03 | 0.005 | Maxim, 1996 |
| 25-200-SW-09 | 08/28/96 | Silver Creek at railroad trestle below Sitzer (continous recorder sta.) | Surface Water | <2/<2 | | <5/<5 | 60/30 | 56.0 | 17.0 | 1.0 | 2.0 | 210 | | 251 | 0 | 245 | 201 | 3 | 10 | 0.05 | 0.009 | Maxim, 1996 |
| 25-200-SW-10 | 10/11/95 | Threemile Creek | Surface Water | <1/<1 | | <5/<5 | <20/40 | 43.0 | 24.0 | 12.0 | 1.0 | 206 | | 228 | 0 | 245 | 201 | 2 | 16 | 0.01 | 0.005 | Maxim, 1996 |
| 25-200-SW-10 | 02/08/96 | Threemile Creek | Surface Water | 7/<1 | | <5/<5 | 60/<20 | 12.0 | 4.0 | 1.0 | 3.0 | 46 | | 38 | 0 | 57 | 47 | 2 | 8 | 0.21 | 0.005 | Maxim, 1996 |
| 25-200-SW-10 | 05/01/96 | Threemile Creek | Surface Water | 2/<1 | | <5/<5 | <20/<20 | 40.0 | 25.0 | 4.0 | 2.0 | 203 | | 224 | 0 | 225 | 184 | 2 | 17 | 0.04 | 0.005 | Maxim, 1996 |
| 25-200-SW-11 | 10/11/95 | Silver Creek at Silver Creek Estates Road | Surface Water | 1/<1 | | <5/<5 | <20/<20 | 98.0 | 35.0 | 29.0 | 4.0 | 389 | | 555 | 0 | 366 | 300 | 10 | 132 | 0.05 | 0.005 | Maxim, 1996 |
| 25-200-SW-11 | 02/08/96 | Silver Creek at Silver Creek Estates Road | Surface Water | 10/<1 | | <5/<5 | 60/<20 | 19.0 | 6.0 | 2.0 | 8.0 | 72 | | 123 | 0 | 74 | 61 | 2 | 21 | 0.20 | | Maxim, 1996 |
| 25-200-SW-11 | 02/08/96 | Duplicate 25-200-SW-11 (02/08/96) | Surface Water | 12/<1 | | <5/<5 | 50/<20 | 18.0 | 6.0 | 2.0 | 6.0 | 70 | | 142 | 0 | 74 | 61 | 4 | 21 | 0.14 | 0.005 | Maxim, 1996 |
| 25-200-SW-11 | 05/01/96 | Silver Creek at Silver Creek Estates Road | Surface Water | 2/<1 | | <5/<5 | <20/<20 | 71.0 | 30.0 | 8.0 | 4.0 | 301 | | 377 | 6 | 265 | 227 | 5 | 85 | 0.03 | 0.005 | Maxim, 1996 |
| 25-200-SW-11 | 08/28/96 | Silver Creek at Silver Creek Estates Road | Surface Water | <2/<2 | | <5/<5 | 60/50 | 112.0 | 48.0 | 22.0 | 5.0 | 477 | | 646 | 0 | 411 | 337 | 9 | 169 | 0.05 | 0.009 | Maxim, 1996 |
| 25-200-SW-11 | 08/28/96 | Duplicate 25-200-SW-11 (08/28/96) | Surface Water | <2/<2 | | <5/<5 | 60/30 | 109.0 | 47.0 | 21.0 | 5.0 | 466 | | 656 | 0 | 417 | 342 | 9 | 170 | 0.05 | 0.005 | Maxim, 1996 |
| 25-365-SW-1 | 09/02/93 | Goldsil Millsite - at toe of berm w/flow gate in Silver Crk | Surface Water | 1.13 | 31.7 | | 8.71 | | | | | 212 | | 213 | | | | <5 | 19 | <0.05 | <0.005 | MDSL/AMRB, 1993a |
| 25-365-SW-2 | 09/02/93 | Goldsil Millsite - Silver Crk at culvert (downgradient) at rd. | Surface Water | 1.69 | 31.7 | | 12.3 | | | | | 195 | | 212 | | | | <5 | 18 | 0.06 | <0.005 | MDSL/AMRB, 1993a |
| 25-365-SW-3 | 09/02/93 | Goldsil Millsite - Silver Crk upgradient (200') from Argo mill bldg. | Surface Water | 1.53 | 31.7 | | 12.4 | | | | | 181 | | 189 | | | | <5 | 18 | 0.09 | <0.005 | MDSL/AMRB, 1993a |
| 25-365-SW-5 | 09/02/93 | Goldsil Millsite - pregnant pond below mill | Surface Water | | | | | | | | | | | | | | | | | | <0.005 | MDSL/AMRB, 1993a |
| 25-024-AD1 | 6/23-24/93 | Drumlummon - Adit discharge on WR4 | Surface Water | 2.1 | 29.4 | | 6.07 | | | | | 319 | | 309 | | | | <5 | 24 | <0.05 | | MDSL/AMRB, 1993b |
| 25-024-SW1 | 6/23-24/93 | Drumlummon - Ottawa Gulch (Silver Crk) upstream of mines and mills | Surface Water | 2.9 | 29.4 | | 6.67 | | | | | 144 | | 137 | | | | <5 | 8.0 | 0.15 | | MDSL/AMRB, 1993b |
| 25-024-SW2 | 6/23-24/93 | Drumlummon - Silver Crk below mines, mills and TP1 | Surface Water | 2.3 | 29.4 | | 4.5 | | | | | 139 | | 148 | | | | <5 | 12 | 0.16 | | MDSL/AMRB, 1994 |
| 25-024-SW3 | 6/23-24/93 | Drumlummon - Silver Crk below tailings TP2, two miles below mills | Surface Water | 6.8 | 29.4 | | 13.7 | | | | | 188 | | 177.00 | | | | <5 | 18 | 0.14 | | MDSL/AMRB, 1994 |
| SW-1 | 07/08/88 | Goldsil Millsite - Silver Crk 3 mi. west of lower gate | Surface Water | | | | | | | | | | | | | | | | | | 0 | MDHES, 1988 |
| SW-2 | 07/08/88 | Goldsil Millsite - Silver Crk 0.9 mi. west of lower gate | Surface Water | | | | | | | | | | | | | | | | | | 0 | MDHES, 1988 |
| SW-3 | 07/08/88 | Goldsil Millsite - Silver Crk at upstream entrance to site | Surface Water | 16.8 | 0 | 0 | 0 | 53.2 | 8.35 | 0 | 0 | | | | | | | | | | 0 | MDHES, 1988 |
| SW-4 | 07/08/88 | Goldsil Millsite - Silver Crk N.E. corner of upper lagoon | Surface Water | | | | | | | | | | | | | | | | | | 0 | MDHES, 1988 |
| SW-5 | 07/08/88 | Goldsil Millsite - Silver Crk at downstream entrance to site | Surface Water | 6.9 | 0 | 0 | 0 | 58.0 | 12.3 | 0 | 0 | | | | | | | | | | 0.005 | MDHES, 1988 |
| SW-6 | 07/08/88 | Goldsil Millsite - Silver Crk just below lower lagoon | Surface Water | | | | | | | | | | | | | | | | | | 0 | MDHES, 1988 |

**Table 3-11. Summary of Silver Creek Drainage Surface Water Chemistry Results**

| Sample Station | Sample Date | Sample Location | Medium | Pb (ug/L) Total/Dissolved | Sb (ug/L) Total/Dissolved | Se (ug/L) Total/Dissolved | Zn (ug/L) Total/Dissolved | Ca (mg/L) | Mg (mg/L) | Na (mg/L) | K (mg/L) | Hardness (mg $CaCO_3$/L) | Total Suspended Solids (mg/L) | Total Dissolved Solids (mg/L) | Carbonate as $CO_3$ (mg/L) | Bicarbonate as $HCO_3$ (mg/L) | Total Alkalinity as $CaCO_3$ (mg/L) | Chloride (mg/L) | Sulfate (mg/L) | $NO_3/NO_2$-N (mg/L) | Total Cyanide (mg/L) | Source/Date |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | WQB-7-Human Health Standard | Surface Water | 15 | 6 | 50 | 2000 | | | | | | | | | | | | | 10000 | 200 | |
| | | WQB-7 Acute Aquatic Life Standard | Surface Water | 197.3* | | 20 | 215.6* | | | | | | | | | | | | | | 22 | |
| | | WQB-7 Chronic Aquatic Life Standard | Surface Water | 7.7* | | 5 | 215.6* | | | | | | | | | | | | | | 5.2 | |
| SW-7 | 07/08/88 | Goldsil Millsite - Silver Crk just below Buck Lake | Surface Water | | | | | | | | | | | | | | | | | | 0 | MDHES, 1988 |
| LL-1 | 07/08/88 | Goldsil Millsite - spring below the lower lagoon | Surface Water | 0 | 0 | 0 | 0 | 69.4 | 22.9 | 8.21 | 0 | | | | | | | | | | 1.690 | MDHES, 1988 |
| ML-1 | 07/08/88 | Goldsil Millsite - lagoon just north of mill | Surface Water | 17.3 | 0 | 0 | 38 | 15.2 | 5.0 | 0 | 0 | | | | | | | | | | 0 | MDHES, 1988 |
| UL-1 | 07/08/88 | Goldsil Millsite - lagoon upstream from mill | Surface Water | 8.1 | 276 | 12.5 | 2040 | 17.2 | 5.11 | 154 | 16.8 | | | | | | | | | | 0.325 | MDHES, 1988 |
| H7 | 12/07/81 | Silver Crk - above Maskelyne Tunnel; above mine office entrance road | Surface Water | 10/10 | | <5/<5 | <10/<10 | 39 | 5 | 4 | 2 | 117 | 10 | 133.00 | 0 | 131.00 | 108.00 | 17 | 1 | | | Goldsil Mining and Milling, Inc., 1984 |
| H7 | 06/10/82 | Silver Crk - above Maskelyne Tunnel; above mine office entrance road | Surface Water | <10 | | | <10 | | | | | | | | | | | | | | 0.408 | Hydrometrics, 1983 |
| H7 | 10/25/82 | Silver Crk - above Maskelyne Tunnel; above mine office entrance road | Surface Water | 10/10 | | | <10/<10 | | | | | | | | | | | | | | | Hydrometrics, 1983 |
| H7 | 12/14/83 | Silver Crk - above Maskelyne Tunnel; above mine office entrance road | Surface Water | | | | | | | | | | | | | | | | | | | Hydrometrics, 1983 |
| H9 | 10/21/81 | Ottawa Gulch just above Obie Adit | Surface Water | <10/<10 | | <5/<5 | 10/10 | 47 | 5 | 1 | 2 | 134 | <1 | 143 | 0 | 147 | 120 | 13 | 2 | | | Goldsil Mining and Milling, Inc., 1984 |
| H11 | 12/14/83 | Jennies Fork; at county road bridge | Surface Water | | | | | | | | | | | | | | | | | | | Hydrometrics, 1983 |
| H12 | 12/14/83 | Silver Creek; below Jennies Fork | Surface Water | | | | | | | | | | | | | | | | | | | Hydrometrics, 1983 |
| H13 | 12/14/83 | Silver Creek above Sawmill Gulch | Surface Water | | | | | | | | | | | | | | | | | | | Hydrometrics, 1983 |
| H14 | 12/14/83 | Sawmill Gulch above Silver Creek | Surface Water | | | | | | | | | | | | | | | | | | | Hydrometrics, 1983 |
| FG1/H15 | 10/21/76 | Silver Creek; below China Gulch | Surface Water | <50 | | | <10 | 55 | 9.9 | 4.0 | 1.8 | | | | | | 171 | 0.21 | 12 | | <20 | Goldsil Mining and Milling, Inc., 1984 |
| FG1/H15 | 11/15/74 | Silver Creek; below China Gulch | Surface Water | | | | | | | | | | | | | | | | | | <2 | Goldsil Mining and Milling, Inc., 1984 |
| FG1/H15 | 11/29/76 | Silver Creek; below China Gulch | Surface Water | | | | | | | | | | | | | | | | | | <1 | Goldsil Mining and Milling, Inc., 1984 |
| FG1/H16 | 10/21/76 | Silver Creek; below China Gulch | Surface Water | <50 | | | <10 | 56 | 17 | 5.5 | 2.0 | | | | | | 201 | 3.3 | 13 | | | Goldsil Mining and Milling, Inc., 1984 |
| H17 | 11/23/74 | Silver Creek above China Gulch | Surface Water | | | | | | | | | | | | | | | | | | | Goldsil Mining and Milling, Inc., 1984 |
| H18 | 11/23/76 | Silver Creek above China Gulch | Surface Water | | | | | | | | | | | | | | | | | | | Goldsil Mining and Milling, Inc., 1984 |
| H19 | 11/23/76 | Silver Creek above China Gulch | Surface Water | | | | | | | | | | | | | | | | | | | Goldsil Mining and Milling, Inc., 1984 |
| H20 | 11/23/76 | China Gulch above Silver Creek | Surface Water | | | | | | | | | | | | | | | | | | | Goldsil Mining and Milling, Inc., 1984 |
| H21 | 11/23/76 | Silver Creek; below China Gulch | Surface Water | | | | | | | | | | | | | | | | | | | Goldsil Mining and Milling, Inc., 1984 |
| H22 | 11/23/76 | Silver Creek above tailings | Surface Water | | | | | | | | | | | | | | | | | | | Goldsil Mining and Milling, Inc., 1984 |
| H23 | 11/23/76 | Silver Creek above tailings | Surface Water | | | | | | | | | | | | | | | | | | | Goldsil Mining and Milling, Inc., 1984 |
| H24 | 11/23/76 | Silver Creek at Mill | Surface Water | | | | | | | | | | | | | | | | | | | Goldsil Mining and Milling, Inc., 1984 |
| H25 | 11/23/76 | Silver Creek below Mill | Surface Water | | | | | | | | | | | | | | | | | | | Goldsil Mining and Milling, Inc., 1984 |
| H26 | 11/23/76 | Silver Creek near Clear Pond | Surface Water | | | | | | | | | | | | | | | | | | | Goldsil Mining and Milling, Inc., 1984 |
| H27 | 11/23/76 | Silver Creek above gravel road | Surface Water | | | | | | | | | | | | | | | | | | | Goldsil Mining and Milling, Inc., 1984 |
| H28 | 11/23/76 | Silver Creek above Sitzer | Surface Water | | | | | | | | | | | | | | | | | | | Goldsil Mining and Milling, Inc., 1984 |
| WQ1/H6 | 09/17/80 | Silver Crk - above Goldsil; at culvert at mill office entrance road | Surface Water | <50/<50 | | | <5/6 | 54.6 | 10.1 | | | 178 | | | 0.0 | 173.2 | 142 | 1.2 | 17.1 | | | Goldsil Mining and Milling, Inc., 1984 |
| WQ1/H6 | 10/23/80 | Silver Crk - above Goldsil; at culvert at mill office entrance road | Surface Water | | | | | 51.4 | 10.0 | | | 170 | | | 0.0 | 186.7 | 153 | 1.4 | | | 0.009 | Goldsil Mining and Milling, Inc., 1984 |
| WQ1/H6 | 10/28/80 | Silver Crk - above Goldsil; at culvert at mill office entrance road | Surface Water | | | | | 59.9 | 9.1 | | | 187 | | | 0.0 | 187.9 | 154 | 1.4 | | | <0.005 | Goldsil Mining and Milling, Inc., 1984 |
| WQ1/H6 | 10/29/80 | Silver Crk - above Goldsil; at culvert at mill office entrance road | Surface Water | | | | | | | 4 | | | | | | | | | | | <0.005 | Goldsil Mining and Milling, Inc., 1984 |
| WQ1/H6 | 10/30/80 | Silver Crk - above Goldsil; at culvert at mill office entrance road | Surface Water | | | | | | | | | | | | | | | | | | <0.005 | Goldsil Mining and Milling, Inc., 1984 |
| WQ1/H6 | 12/10/80 | Silver Crk - above Goldsil; at culvert at mill office entrance road | Surface Water | | | | | | | | | | | | | | | | | | <0.001 | Goldsil Mining and Milling, Inc., 1984 |
| WQ1/H6 | 06/30/81 | Silver Crk - above Goldsil; at culvert at mill office entrance road | Surface Water | | | | | | | 5 | | | | | | | | | | | <0.005 | Goldsil Mining and Milling, Inc., 1984 |
| WQ2/H5 | 10/09/80 | Silver Crk - at entrance to Goldsil mill | Surface Water | | | | | | | | | | | | | | | | | | | Goldsil Mining and Milling, Inc., 1984 |
| WQ2/H5 | 10/15/80 | Silver Crk - at entrance to Goldsil mill | Surface Water | | | | | | | | | | | | | | | | | | | Goldsil Mining and Milling, Inc., 1984 |
| WQ2/H5 | 10/23/80 | Silver Crk - at entrance to Goldsil mill | Surface Water | | | | | 59.1 | 15.4 | | | 211 | | | 0.0 | 226.9 | 186 | 1.7 | | | 0.010 | Goldsil Mining and Milling, Inc., 1984 |
| WQ2/H5 | 10/28/80 | Silver Crk - at entrance to Goldsil mill | Surface Water | | | | | 64.8 | 13.6 | | | 218 | | | 0.0 | 219.6 | 180 | | | | <0.005 | Goldsil Mining and Milling, Inc., 1984 |
| WQ2/H5 | 10/29/80 | Silver Crk - at entrance to Goldsil mill | Surface Water | | | | | | | 5 | | | | | | | | | | | 0.019 | Goldsil Mining and Milling, Inc., 1984 |
| WQ2/H5 | 06/30/81 | Silver Crk - at entrance to Goldsil mill | Surface Water | | | | | | | 5 | | | | | | | | | | | <0.005 | Goldsil Mining and Milling, Inc., 1984 |
| WQ2/H5 | 06/10/82 | Silver Crk - at entrance to Goldsil mill | Surface Water | | | | | | | | | | | | | | | | | | 0.011 | Hydrometrics, 1983 |
| WQ2/H5 | 10/25/82 | Silver Crk - at entrance to Goldsil mill | Surface Water | | | | | | | | | | | | | | | | | | <0.005 | Hydrometrics, 1983 |
| WQ2/H5 | 11/16/83 | Silver Crk - at entrance to Goldsil mill | Surface Water | | | | | | | | | | | | | | | | | | <0.005 | Hydrometrics, 1983 |
| WQ12/H4 | 10/09/80 | Silver Crk - above Upper Pond | Surface Water | | | | | | | | | | | | | | | | | | | Goldsil Mining and Milling, Inc., 1984 |
| WQ12/H4 | 10/15/80 | Silver Crk - above Upper Pond | Surface Water | | | | | | | | | | | | | | | | | | | Goldsil Mining and Milling, Inc., 1984 |
| WQ12/H4 | 10/29/80 | Silver Crk - above Upper Pond | Surface Water | | | | | | | 5 | | | | | | | | | | | <0.005 | Goldsil Mining and Milling, Inc., 1984 |
| WQ12/H4 | 06/30/81 | Silver Crk - above Upper Pond | Surface Water | | | | | | | 5 | | | | | | | | | | | <0.005 | Goldsil Mining and Milling, Inc., 1984 |
| WQ10 | 10/28/80 | Silver Crk - between Upper & Lower Ponds | Surface Water | | | | | 63.5 | 15.9 | | | 224 | | | 0.0 | 229.4 | 188 | 1.9 | | | <0.005 | Goldsil Mining and Milling, Inc., 1984 |
| WQ3/H3 | 10/09/80 | Silver Crk - above seep; opposite White's tailings pond | Surface Water | | | | | | | | | | | | | | | | | | | Goldsil Mining and Milling, Inc., 1984 |
| WQ3/H3 | 10/15/80 | Silver Crk - above seep; opposite White's tailings pond | Surface Water | | | | | | | | | | | | | | | | | | | Goldsil Mining and Milling, Inc., 1984 |
| WQ3/H3 | 10/23/80 | Silver Crk - above seep; opposite White's tailings pond | Surface Water | | | | | 60.9 | 14.5 | | | 212 | | | 0.0 | 245.2 | 201 | 3.2 | | | 0.15 | Goldsil Mining and Milling, Inc., 1984 |
| WQ3/H3 | 10/28/80 | Silver Crk - above seep; opposite White's tailings pond | Surface Water | | | | | 66.8 | 16.8 | | | 236 | | | 0.0 | 234.2 | 192 | 2.3 | | | 0.028 | Goldsil Mining and Milling, Inc., 1984 |
| WQ3/H3 | 12/10/80 | Silver Crk - above seep; opposite White's tailings pond | Surface Water | | | | | | | | | | | | | | | | | | 0.021 | Goldsil Mining and Milling, Inc., 1984 |
| WQ5 | 10/09/80 | Silver Crk - below seep | Surface Water | | | | | | | | | | | | | | | | | | | Goldsil Mining and Milling, Inc., 1984 |
| WQ5 | 10/15/80 | Silver Crk - below seep | Surface Water | | | | | | | | | | | | | | | | | | | Goldsil Mining and Milling, Inc., 1984 |
| WQ5 | 10/23/80 | Silver Crk - below seep | Surface Water | | | | | 65.1 | 26.7 | | | 272 | | | 0.0 | 246.4 | 202 | 4.5 | | | 0.10 | Goldsil Mining and Milling, Inc., 1984 |
| WQ5 | 10/28/80 | Silver Crk - below seep | Surface Water | | | | | 65.4 | 16.8 | | | 232 | | | 0.0 | 233.0 | 191 | 2.8 | | | 0.051 | Goldsil Mining and Milling, Inc., 1984 |
| WQ5 | 12/10/80 | Silver Crk - below seep | Surface Water | | | | | | | | | | | | | | | | | | 0.029 | Goldsil Mining and Milling, Inc., 1984 |

**Table 3-11. Summary of Silver Creek Drainage Surface Water Chemistry Results**

| Sample Station | Sample Date | Sample Location | Medium | Pb (ug/L) Total/Dissolved | Sb (ug/L) Total/Dissolved | Se (ug/L) Total/Dissolved | Zn (ug/L) Total/Dissolved | Ca (mg/L) | Mg (mg/L) | Na (mg/L) | K (mg/L) | Hardness (mg $CaCO_3$/L) | Total Suspended Solids (mg/L) | Total Dissolved Solids (mg/L) | Carbonate as $CO_3$ (mg/L) | Bicarbonate as $HCO_3$ (mg/L) | Total Alkalinity as $CaCO_3$ (mg/L) | Chloride (mg/L) | Sulfate (mg/L) | $NO_3/NO_2$-N (mg/L) | Total Cyanide (mg/L) | Source/Date |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | WQB-7-Human Health Standard | Surface Water | 15 | 6 | 50 | 2000 | | | | | | | | | | | | | 10000 | 200 | |
| | | WQB-7 Acute Aquatic Life Standard | Surface Water | 197.3* | | 20 | 215.6* | | | | | | | | | | | | | | 22 | |
| | | WQB-7 Chronic Aquatic Life Standard | Surface Water | 7.7* | | 5 | 215.6* | | | | | | | | | | | | | | 5.2 | |
| WQ6/H2 | 11/15/76 | Silver Crk - below seep | Surface Water | | | | | | | | | | | | | | | | | | 0.010 | Goldsil Mining and Milling, Inc., 1984 |
| WQ6/H2 | 11/29/76 | Silver Crk - below seep | Surface Water | | | | | | | | | | | | | | | | | | 0.008 | Goldsil Mining and Milling, Inc., 1984 |
| WQ6/H2 | 09/17/80 | Silver Crk - above Buck Lake | Surface Water | <50/<50 | | | <5/20 | 55.9 | 15.3 | | | 202 | | | 0.0 | 224.5 | 184 | 2.8 | 21.4 | | 0.117 | Goldsil Mining and Milling, Inc., 1984 |
| WQ6/H2 | 10/09/80 | Silver Crk - above Buck Lake | Surface Water | | | | | | | | | | | | | | | | | | | Goldsil Mining and Milling, Inc., 1984 |
| WQ6/H2 | 10/15/80 | Silver Crk - above Buck Lake | Surface Water | | | | | | | | | | | | | | | | | | | Goldsil Mining and Milling, Inc., 1984 |
| WQ6/H2 | 10/23/80 | Silver Crk - above Buck Lake | Surface Water | | | | | 63.3 | 18.2 | | | 233 | | | 0.0 | 245.2 | 201 | 4.4 | | | 0.10 | Goldsil Mining and Milling, Inc., 1984 |
| WQ6/H2 | 10/28/80 | Silver Crk - above Buck Lake | Surface Water | | | | | 65.6 | 15.4 | | | 227 | | | 0.0 | 233.0 | 191 | 2.9 | | | 0.041 | Goldsil Mining and Milling, Inc., 1984 |
| WQ6/H2 | 10/29/80 | Silver Crk - above Buck Lake | Surface Water | | | | | | | 9 | | | | | | | | | | | 0.062 | Goldsil Mining and Milling, Inc., 1984 |
| WQ6/H2 | 06/30/81 | Silver Crk - above Buck Lake | Surface Water | | | | | | | 6 | | | | | | | | | | | <0.005 | Goldsil Mining and Milling, Inc., 1984 |
| WQ6/H2 | 06/21/82 | Silver Crk - above Buck Lake | Surface Water | | | | | | | | | | | | | | | | | | 0.011 | Hydrometrics, 1983 |
| WQ6/H2 | 10/25/82 | Silver Crk - above Buck Lake | Surface Water | | | | | | | | | | | | | | | | | | 0.009 | Hydrometrics, 1983 |
| WQ4/H1 | 09/17/80 | Silver Crk - seep | Surface Water | 50/50 | | | 10/10 | 61.5 | 19.7 | | | 235 | | | 0.0 | 251.3 | 206 | 70.3 | 106.0 | | 8.6 | Goldsil Mining and Milling, Inc., 1984 |
| WQ4/H1 | 10/23/80 | Silver Crk - seep | Surface Water | | | | | 62.1 | 20.0 | | | 237 | | | 0.0 | 263.0 | 232 | 44.4 | | | 2.0 | Goldsil Mining and Milling, Inc., 1984 |
| WQ4/H1 | 10/28/80 | Silver Crk - seep | Surface Water | | | | | 67.2 | 18.2 | | | 243 | | | 0.0 | 273.3 | 224 | 40.4 | | | 1.31 | Goldsil Mining and Milling, Inc., 1984 |
| WQ4/H1 | 10/29/80 | Silver Crk - seep | Surface Water | | | | | | | 65 | | | | | | | | | | | 0.98 | Goldsil Mining and Milling, Inc., 1984 |
| WQ4/H1 | 10/29/80 | Silver Crk - seep | Surface Water | | | | | | | | | | | | | | | | | | 0.86 | Goldsil Mining and Milling, Inc., 1984 |
| WQ4/H1 | 12/10/80 | Silver Crk - seep | Surface Water | | | | | | | | | | | | | | | | | | 0.462 | Goldsil Mining and Milling, Inc., 1984 |
| WQ4/H1 | 06/30/81 | Silver Crk - seep | Surface Water | | | | | | | 33 | | | | | | | | | | | 0.15 | Goldsil Mining and Milling, Inc., 1984 |
| WQ4/H1 | 06/30/81 | Silver Crk - seep | Surface Water | | | | | | | 34 | | | | | | | | | | | 0.17 | Goldsil Mining and Milling, Inc., 1984 |
| WQ4/H1 | 06/21/82 | Silver Crk - seep | Surface Water | | | | | | | | | | | | | | | | | | 0.408 | Hydrometrics, 1983 |
| WQ4/H1 | 10/25/82 | Silver Crk - seep | Surface Water | | | | | | | | | | | | | | | | | | 0.354 | Hydrometrics, 1983 |
| WQ4/H1 | 10/25/82 | Silver Crk - seep | Surface Water | | | | | | | | | | | | | | | | | | 0.009 | Hydrometrics, 1983 |
| WQ7 | 10/09/80 | Silver Crk - below Buck Lake | Surface Water | | | | | | | | | | | | | | | | | | | Goldsil Mining and Milling, Inc., 1984 |
| WQ7 | 10/23/80 | Silver Crk - below Buck Lake | Surface Water | | | | | 62.3 | 18.6 | | | 232 | | | 0.0 | 236.7 | 194 | 4.3 | | | 0.020 | Goldsil Mining and Milling, Inc., 1984 |
| WQ7 | 10/28/80 | Silver Crk - below Buck Lake | Surface Water | | | | | 65.3 | 17.7 | | | 236 | | | 0.0 | 230.6 | 189 | 3.3 | | | 0.075 | Goldsil Mining and Milling, Inc., 1984 |
| WQ7 | 12/10/80 | Silver Crk - below Buck Lake | Surface Water | | | | | | | | | | | | | | | | | | | Goldsil Mining and Milling, Inc., 1984 |
| WQ8 | 10/23/80 | Goldsil - Upper Holding Pond (clear water) | Surface Water | | | | | 59.0 | 15.3 | | | 210 | | | 0.0 | 229.4 | 188 | 1.8 | | | 0.7 | Goldsil Mining and Milling, Inc., 1984 |
| WQ8 | 10/28/80 | Goldsil - Upper Holding Pond (clear water) | Surface Water | | | | | 67.5 | 14.1 | | | 227 | | | 0.0 | 220.8 | 181 | 1.9 | | | <0.005 | Goldsil Mining and Milling, Inc., 1984 |
| WQ9 | 10/23/80 | Goldsil - Lower Tailings Pond | Surface Water | | | | | 57.1 | 14.5 | | | 202 | | | 0.0 | 194.0 | 139 | 3.3 | | | 0.29 | Goldsil Mining and Milling, Inc., 1984 |
| WQ9 | 10/28/80 | Goldsil - Lower Tailings Pond | Surface Water | | | | | 47.3 | 13.6 | | | 174 | | | 0.0 | 187.9 | 154 | 4.1 | | | 0.328 | Goldsil Mining and Milling, Inc., 1984 |
| WQ10 | 10/28/80 | Silver Crk - below Clear Pond | Surface Water | | | | | 63.5 | 15.9 | | | 224 | | | 0.0 | 229.4 | 188 | 1.9 | | | <0.005 | Goldsil Mining and Milling, Inc., 1984 |
| WQ11 | 12/10/80 | Silver Crk - Birdseye Road | Surface Water | | | | | | | | | | | | | | | | | | | Goldsil Mining and Milling, Inc., 1984 |
| Sawmill C | 11/20/80 | Sawmill Crk | Surface Water | | | | | 61.8 | 14.8 | 1.9 | 2.6 | 215.23 | 5.39 | 231.4 | 1.7 | 235 | 195.58 | 1.5 | 21.2 | 0.07 | | Goldsil Mining and Milling, Inc., 1984 |
| Sawmill C | 09/19/81 | Sawmill Crk | Surface Water | | | | | 56.4 | 14.4 | 2.0 | 2.5 | 200.10 | 29.5 | 219.05 | 0 | 225 | 184.54 | 1.0 | 22.2 | 0.084 | | Goldsil Mining and Milling, Inc., 1984 |
| Ottawa C | 12/78 | Ottawa Crk | Surface Water | | | | | 45.9 | 4.3 | 2.2 | 2.1 | | | | 0 | 149.0 | | 0.65 | 14.2 | 0.418 | | Goldsil Mining and Milling, Inc., 1984 |
| Ottawa C | 01/30/79 | Ottawa Crk | Surface Water | | | | | 46.8 | 4.4 | 2.3 | 2.2 | | | | 0 | 146 | | 8 | 16.2 | 0.474 | | Goldsil Mining and Milling, Inc., 1984 |
| Station #1 | 10/21/76 | Silver Creek below China Gulch | Surface Water | <50 | | | <10 | 55 | 9.9 | 4.0 | 1.8 | | | | | | 171 | 0.21 | 12 | | <0.02 | MT Dept. of Fish and Game, 1977 |
| Station #1 | 11/15/76 | Silver Creek below China Gulch | Surface Water | | | | | | | | | | | | | | | | | | <0.002 | MT Dept. of Fish and Game, 1977 |
| Station #1 | 11/29/76 | Silver Creek below China Gulch | Surface Water | | | | | | | | | | | | | | | | | | 0.001 | MT Dept. of Fish and Game, 1977 |
| Station #1 | 01/12/77 | Silver Creek below China Gulch | Surface Water | | | | <10 | | | | | | | | | | | | | | <0.001 | MT Dept. of Fish and Game, 1977 |
| Station #1 | 01/31/77 | Silver Creek below China Gulch | Surface Water | | | | | | | | | | | | | | | | | | 0.002 | MT Dept. of Fish and Game, 1977 |
| Station #1A | 01/31/77 | Silver Creek near Goldsil tailings pile | Surface Water | | | | | | | | | | | | | | | | | | <0.001 | MT Dept. of Fish and Game, 1977 |
| Station #2A | 01/12/77 | Pond between mill and no trespassing access road east of mill | Surface Water | | | | <10 | | | | | | | | | | | | | | 0.008 | MT Dept. of Fish and Game, 1977 |
| Station #2B | 01/12/77 | Silver Creek between mill and upper tailings pond at headgate | Surface Water | | | | <10 | | | | | | | | | | | | | | <0.001 | MT Dept. of Fish and Game, 1977 |
| Station #3 | 10/21/76 | Upper tailings pond | Surface Water | <50 | | | 680 | 89 | 51 | 93 | 39 | | | | | | 237 | 148 | 230 | | 6.5 | MT Dept. of Fish and Game, 1977 |
| Station #3 | 11/15/76 | Upper tailings pond | Surface Water | | | | | | | | | | | | | | | | | | 6.95 | MT Dept. of Fish and Game, 1977 |
| Station #3 | 01/12/77 | Upper tailings pond | Surface Water | | | | 6500 | | | | | | | | | | | | | | 22.0 | MT Dept. of Fish and Game, 1977 |
| Station #6 | 11/15/76 | Silver Creek below lower tailings pond | Surface Water | | | | | | | | | | | | | | | | | | 0.010 | MT Dept. of Fish and Game, 1977 |
| Station #6 | 11/29/76 | Silver Creek below lower tailings pond | Surface Water | | | | | | | | | | | | | | | | | | 0.008 | MT Dept. of Fish and Game, 1977 |
| Station #6 | 01/12/77 | Silver Creek below lower tailings pond | Surface Water | | | | <10 | | | | | | | | | | | | | | | MT Dept. of Fish and Game, 1977 |
| Station #6 | 01/31/77 | Silver Creek below lower tailings pond | Surface Water | | | | | | | | | | | | | | | | | | 0.008 | MT Dept. of Fish and Game, 1977 |
| Station #7 | 10/21/76 | Silver Creek at gravel road 0.9 mile from Lincoln highway | Surface Water | <50 | | | <10 | 56 | 17 | 5.5 | 2.0 | | | | | | 201 | 3.3 | 13 | | <0.02 | MT Dept. of Fish and Game, 1977 |

Note: WQB-7 standards for metals (except aluminum) in surface water are based upon the analysis of total recoverable metals.
Aluminum is based on dissolved metals.

*Based on a hardness of 200 mg/l as $CaCO_3$ (note that average hardness for previous data is 190 mg/l $CaCO_3$)

**Aquatic life standards are based on specization of Cr(III) and Cr(VI). The analyses performed were total Cr.

## 3.7 FISH TISSUE

Several investigations of the fishery and water quality in Silver Creek have been performed by State of Montana wildlife and health agencies. These include an evaluation of the causes of a fish kill in Silver Creek which occurred in September 1976 (Montana Department of Fish and Game, 1977), a statewide water pollution study (MDFWP, 1984) and contaminant monitoring of fish and sediments (MDFWP, 1994). Concentrations of mercury as high as 4.3 mg/Kg in fish tissue have been measured. The U.S. Food and Drug Administration action level is 1.0 mg/Kg of mercury for fish. The fishery was made a catch and release only in 1983 by the Fish and Game Commission to protect human health. Fish tissue sample results are summarized in Table 3-12.

## 3.8 GROUNDWATER CHARACTERISTICS

Groundwater and adit discharge samples were collected during previous investigations in the Silver Creek drainage basin. A total of 38 samples have been collected from 27 different locations. Of these 38 samples, 24 were groundwater samples and 14 were adit discharge samples. The sample results are presented in Table 3-13.

Maxim (DEQ-AMRB/Maxim, 1996) collected groundwater samples from four wells in the Marysville area. These wells represent water quality in both the shallow alluvial aquifer and the deeper bedrock aquifer. Water quality samples contained low concentrations of dissolved minerals and metals. Two of the wells contained elevated concentrations of nutrients. All of the samples collected met Federal drinking water Maximum Contaminant Level (MCL) and Secondary Maximum Contaminant Level (SMCL) standards.

An operating permit submitted to MDSL (Goldsil Mining and Milling, Inc., 1984a and 1984b) included an inventory of wells and springs in the Marysville area and chemical analyses of 13 groundwater sampling sites. Groundwater, mine discharge water and spring water were reported as high quality, very hard, calcium-bicarbonate type. With the exception of total iron and total and dissolved manganese, metals concentrations were very low and often less than laboratory detection limits. All of the analyses reported would meet Federal primary drinking water standards and would meet Federal secondary standards with iron and manganese removal.

As part of the Phase II site characterization of a potential mine/mill repository site, an assessment of the depth and chemistry of shallow groundwater contained in the alluvial aquifer was undertaken in the Goldsil tailings area. Monitoring well drilling for MW1, MW2, MW3 and MW4 was initiated on November 21, 2002 and completed on November 22, 2002 by O'Keefe Drilling Company, Butte, Montana. The wells were drilled using an air rotary drilling rig. The monitoring wells were completed in an area where preliminary engineering estimates indicate the potential for a mine/mill waste repository that could accommodate the bulk of the waste identified to date. The potential repository site area and monitoring well locations are shown in Figure 3-19.

**Table 3-12. Summary of Silver Creek Drainage Fish Tissue Mercury Results**

| Fish Species | Sampling Date | Site Description | Size range (inches) | Number of Samples | Hg (ug/g) | Hg Concentration (ug/g wet weight) Mean | Range | Reference |
|---|---|---|---|---|---|---|---|---|
| Cutthroat trout | 1992 | not available | 12.7 | 1 | 1.6 | | | MWFP and MDHES, 1994 |
| Cutthroat trout | 1992 | not available | 17.1 | 1 | 3.1 | | | MWFP and MDHES, 1994 |
| Cutthroat trout | 1992 | not available | 18.7 | 1 | 3.0 | | | MWFP and MDHES, 1994 |
| Cutthroat trout | June, 1983 | above Buck Lake | 5.8-17.0 | 6 | | 1.68 | 0.38-4.30 | MWFP, 1984 |
| Cutthroat trout | June, 1983 | near Chairman Gulch | 5.4-9.9 | 5 | | 0.38 | 0.29-0.52 | MWFP, 1984 |

**Table 3-13. Summary of Previous Silver Creek Drainage Groundwater and Adit Discharge Chemistry Results**

| Sample Station | Sample Date | Sample Location | Medium | Well Depth (ft.) | Aquifer | Discharge (cfs) | Field pH (s.u.) | Lab pH (s.u.) | Field Specific Conductivity (umhos/cm) | Lab Specific Conductivity (umhos/cm) | Lab Turbidity (JTU) | Water Temp (C) | Oxidation Reduction Potential (mv) | Ag (ug/L) Total/Dissolved | Al (ug/L) Total/Dissolved | As (ug/L) Total/Dissolved | Ba (ug/L) Total/Dissolved |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | WQB-7 Ground Water Human Health Standard | Groundwater | | | | | | | | | | | 100 | | 20 | 2000 |
| PIPINICH 25-200-GW-1 | 10/11/95 | Pipinich Residence | Groundwater | 75 | Granite Bedrock | | 7.0 | 7.4 | 238 | 291 | | 7.0 | | /50 | /200 | /1 | /200 |
| PIPINICH 25-200-GW-1 | 05/01/96 | Pipinich Residence | Groundwater | 75 | Granite Bedrock | | 6.6 | 7.1 | 353 | 329 | | 7.5 | | /50 | /200 | /1 | /200 |
| HULL 25-200-GW-2 | 10/11/95 | Hull Residence | Groundwater | 155 | Granite Bedrock | | 6.9 | 7.8 | 216 | 281 | | 7.0 | | /50 | /200 | /1 | /200 |
| HULL 25-200-GW-2 | 05/01/96 | Hull Residence | Groundwater | 155 | Granite Bedrock | | 6.0 | 7.3 | 294 | 285 | | 6.0 | | /50 | /200 | /2 | /200 |
| M-VILLE 25-200-GW-3 | 10/11/95 | Marysville House | Groundwater | 28 | Alluvium | | 6.8 | 7.3 | 163 | 212 | | 6.0 | | /50 | /200 | /1 | /200 |
| HALL 25-200-GW-4 | 10/11/95 | Hall Residence | Groundwater | 105 | Granite Bedrock | | 6.8 | 7.8 | 238 | 257 | | 10.0 | | /50 | /200 | /1 | /200 |
| HALL 25-200-GW-4 | 05/01/96 | Hall Residence | Groundwater | 105 | Granite Bedrock | | 7.2 | 7.3 | 181 | 216 | | 8.0 | | /50 | /200 | /1 | /200 |
| 25-200-PS-01 | 10/11/95 | Bald Mountain (at culvert below ski area parking lot) | Adit Discharge | | | 0.27 | 8.1 | 8.3 | 256 | 237 | | 8.0 | +150 | 50/50 | 200/200 | 4/4 | 200/200 |
| 25-200-PS-01 | 02/08/96 | Bald Mountain (at culvert below ski area parking lot) | Adit Discharge | | | 0.2 | 7.7 | 7.6 | 245 | 241 | | 6.0 | | 50/50 | 200/200 | 4/3 | 200/200 |
| 25-200-PS-01 | 05/01/96 | Bald Mountain (at culvert below ski area parking lot) | Adit Discharge | | | 0.34 | 7.7 | 7.8 | 356 | 253 | | 5.0 | | 50/50 | 200/200 | 2/2 | 200/200 |
| 25-200-PS-01A | 10/11/95 | Bald Mountain (at black pipe draining adit to storage tank) | Adit Discharge | | | 0.13 | 7.8 | 8.1 | 240 | 217 | | 8.5 | +195 | 50/50 | 200/200 | 5/4 | 200/200 |
| 25-200-PS-02 | 10/11/95 | Drumlummon adit | Adit Discharge | | | 0.1 | 7.7 | 8.0 | 605 | 528 | | 11.0 | -75 | 50/50 | 200/200 | 20/18 | 200/200 |
| 25-200-PS-02 | 02/08/96 | Drumlummon adit | Adit Discharge | | | 0.08 | 7.5 | 7.2 | 571 | 283 | | 6.0 | | 50/50 | 300/200 | 16/16 | 200/200 |
| 25-200-PS-02 | 05/01/96 | Drumlummon adit | Adit Discharge | | | 0.07 | 6.4 | 7.8 | 603 | 526 | | 8.0 | | 50/50 | 200/200 | 21/21 | 200/200 |
| Adit #1 | 07/17/96 | Belmont Mine adit | Adit Discharge | | | | | | | | | 8.0 | | 20 | 2800 | 3 | 100 |
| Adit #18 | 07/17/96 | Collapsed mine adit near the ski base area | Adit Discharge | | | | | | | | | 5.0 | | 20 | 200 | 2 | 100 |
| Adit #2 | 07/17/96 | Belmont Mine adit | Adit Discharge | | | | | | | | | 5.0 | | 20 | 200 | 2 | 100 |
| 25-024-AD1 | 6/23-24/94 | Drumlummon Mill; adit discharge on WR4 | Adit Discharge | | | | | | | | | | | 0.14 | | 34.9 | 128 |
| H8 | 08/27/81 | Maskelyne Tunnel discharge at culvert | Adit Discharge | | | | | 7.0 | | 449 | 4.4 | | | <5 | 100 | <5 | 100 |
| H8 | 12/07/81 | Maskelyne Tunnel discharge at culvert | Adit Discharge | | | | | 7.3 | | 557 | 5.9 | | | <5 | <100 | 33 | 200 |
| H10 | 10/21/81 | Obie adit discharge | Adit Discharge | | | 0.009 | | 7.2 | 287 | 269 | 0.56 | 4.8 | | <5/<5 | <100/<100 | <5/<5 | <100/<100 |
| TP #1 | 10/06/83 | Tailings Pond Groundwater Monitoring System, Site #1 | Groundwater | | | | | | | | | | | | | | |
| TP #2 | 10/06/83 | Tailings Pond Groundwater Monitoring System, Site #2 | Groundwater | | | | | 7.7 | | 525 | | | | | | | |
| TP #4 | 10/06/83 | Tailings Pond Groundwater Monitoring System, Site #4 | Groundwater | | | | | 7.3 | | 455 | | | | | | | |
| TP #5 | 10/06/83 | Tailings Pond Groundwater Monitoring System, Site #5 | Groundwater | | | | | 7.2 | | 452 | | | | | | | |
| TP #1 SEEP | 11/16/83 | Seep near Tailings Pond Groundwater Monitoring System, Site #1 | Groundwater | | | | | | | | | | | | | | |
| W-8 | 12/13/83 | Robert O'Connell residence, Marysville | Groundwater | | | | | 6.7 | | 260 | 0.44 | | | | /<100 | | |
| W-22 | 12/13/83 | Thomas residence, Marysville | Groundwater | | | | | | | | | | | | /<100 | | |
| W-35 | 12/13/83 | Goldsil Mining and Milling, Inc., mill office supply well | Groundwater | | | | | | | | | | | | /<100 | | |
| E MILLER | 10/21/81 | Emma Miller Mine (shaft) | Groundwater | | | | | 7.2 | | 223 | 0.60 | | | <5/<5 | <100/<100 | <5/<5 | <100/<10 |
| DRUMLUMMON | 01/08/82 | Drumlummon Mine No.1 shaft (28 ft. below water surface) | Groundwater | | | | | 7.4 | | 560 | 6.7 | | | <5/<5 | 100/100 | 37/15 | <100/<10 |
| GW-1 | 9/2/87 | Sump connecting four wells near the upstream tailings pond | Groundwater | | | | | | | | | | | | | | |
| Station #5 | 11/29/76 | Seep into Silver Creek between upper and lower tailings ponds | Groundwater | | | | | | | | | | | | | | |
| Station #5 | 01/12/77 | Seep into Silver Creek between upper and lower tailings ponds | Groundwater | | | | | | | | | | | | | | |
| Station #5A | 01/26/77 | Seep into Silver Creek at lower tailings pond; western portion | Groundwater | | | | | | | | | | | | | | |
| Station #5A | 01/31/77 | Seep into Silver Creek at lower tailings pond; western portion | Groundwater | | | | | | | | | | | | | | |
| Station #5B | 01/26/77 | Seep into Silver Creek at lower tailings pond; eastern portion | Groundwater | | | | | | | | | | | | | | |
| Station #5B | 01/31/77 | Seep into Silver Creek at lower tailings pond; eastern portion | Groundwater | | | | | | | | | | | | | | |

Note: WQB-7 standards for metals in groundwater are based upon the dissolved portion of the sample (after filtration through a 0.45 um membrane filter)

**Table 3-13. Summary of Previous Silver Creek Drainage Groundwater and Adit Discharge Chemistry Results**

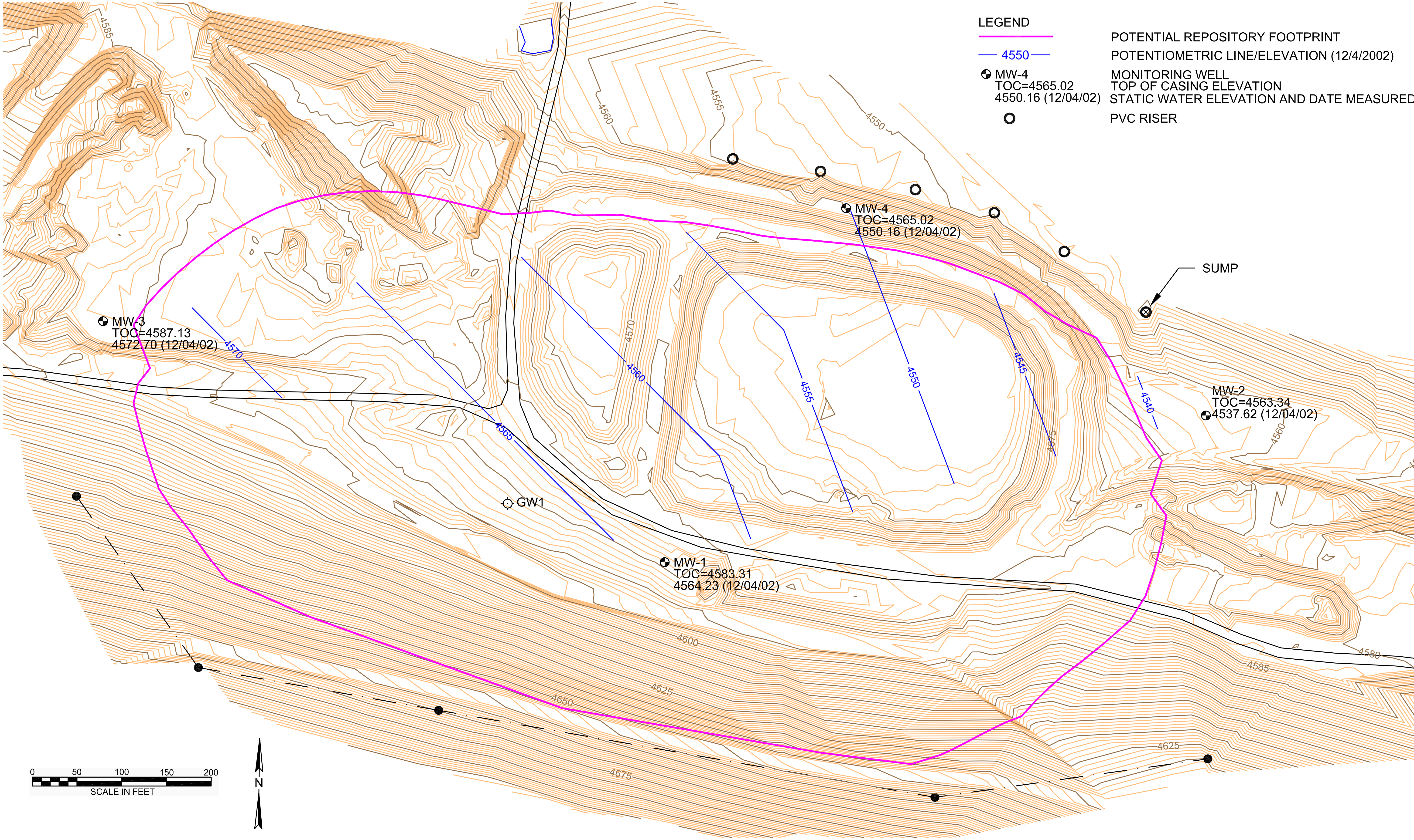
| Sample Station | Sample Date | Sample Location | Medium | Cd (ug/L) Total/Dissolved | Co (ug/L) | Cr (ug/L) Total/Dissolved | Cu (ug/L) Total/Dissolved | Fe (ug/L) Total/Dissolved | Hg (ug/L) Total/Dissolved | Mn (ug/L) Total/Dissolved | Ni (ug/L) Total/Dissolved | Pb (ug/L) Total/Dissolved | Sb (ug/L) Total/Dissolved | Se (ug/L) Total/Dissolved | V (ug/L) Total/Dissolved | Zn (ug/L) Total/Dissolved | Ca (mg/L) | Mg (mg/L) | Na (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | WQB-7 Ground Water Human Health Standard | Groundwater | 5 | | 100 | 1300 | 300 | 2 | 50 | 100 | 15 | 6 | 50 | | 2000 | | | |
| PIPINICH 25-200-GW-1 | 10/11/95 | Pipinich Residence | Groundwater | /0.2 | | /10 | /3 | /50 | /0.2 | /15 | /2 | /1 | | /5 | | /50 | 48.0 | 6.0 | 5.0 |
| PIPINICH 25-200-GW-1 | 05/01/96 | Pipinich Residence | Groundwater | /0.2 | | /10 | /5 | /50 | /0.2 | /15 | /2 | /1 | | /5 | | /50 | 50.0 | 8.0 | 1.0 |
| HULL 25-200-GW-2 | 10/11/95 | Hull Residence | Groundwater | /0.2 | | /10 | /28 | /50 | /0.2 | /15 | /2 | /1 | | /5 | | /20 | 52.0 | 4.0 | 5.0 |
| HULL 25-200-GW-2 | 05/01/96 | Hull Residence | Groundwater | /0.2 | | /10 | /16 | /50 | /0.2 | /15 | /2 | /1 | | /5 | | /30 | 46.0 | 6.0 | 1.0 |
| M-VILLE 25-200-GW-3 | 10/11/95 | Marysville House | Groundwater | /0.2 | | /10 | /50 | /50 | /0.2 | /15 | /2 | /1 | | /5 | | /20 | 26.0 | 4.0 | 9.0 |
| HALL 25-200-GW-4 | 10/11/95 | Hall Residence | Groundwater | /0.2 | | /10 | /10 | /50 | /0.2 | /15 | /2 | /1 | | /5 | | /20 | 1.0 | 1.0 | 54.0 |
| HALL 25-200-GW-4 | 05/01/96 | Hall Residence | Groundwater | /0.2 | | /10 | /5 | /50 | /0.2 | /15 | /2 | /1 | | /5 | | /20 | 1.0 | 1.0 | 43.0 |
| 25-200-PS-01 | 10/11/95 | Bald Mountain (at culvert below ski area parking lot) | Adit Discharge | .2/.2 | | 10/10 | 1/1 | 100/50 | .2/.2 | 15/15 | 2/2 | 1/1 | | 5/5 | | 20/20 | 41.0 | 4.0 | 2.0 |
| 25-200-PS-01 | 02/08/96 | Bald Mountain (at culvert below ski area parking lot) | Adit Discharge | .2/.2 | | 10/10 | 5/5 | 150/50 | .2/.2 | 23/15 | 2/2 | 1/1 | | 5/5 | | 70/20 | 43.0 | 4.0 | 1.0 |
| 25-200-PS-01 | 05/01/96 | Bald Mountain (at culvert below ski area parking lot) | Adit Discharge | .2/.2 | | 10/10 | 5/5 | 130/50 | .2/.2 | 16/15 | 2/2 | 1/1 | | 5/5 | | 30/20 | 39.0 | 5.0 | 1.0 |
| 25-200-PS-01A | 10/11/95 | Bald Mountain (at black pipe draining adit to storage tank) | Adit Discharge | .2/.2 | | 10/10 | 1/1 | 50/50 | .2/.2 | 15/15 | 2/2 | 1/1 | | 5/5 | | 70/140 | 39.0 | 4.0 | 3.0 |
| 25-200-PS-02 | 10/11/95 | Drumlummon adit | Adit Discharge | .2/.2 | | 10/10 | 1/1 | 900/310 | .2/.2 | 0 | 2/2 | 1/1 | | 5/5 | | 20/20 | 76.0 | 22.0 | 13.0 |
| 25-200-PS-02 | 02/08/96 | Drumlummon adit | Adit Discharge | .2/.2 | | 10/10 | 5/5 | 3050/340 | .2/.2 | 0 | 2/2 | 1/1 | | 5/5 | | 70/20 | 77.0 | 23.0 | 2.0 |
| 25-200-PS-02 | 05/01/96 | Drumlummon adit | Adit Discharge | .2/.2 | | 10/10 | 5/5 | 1220/560 | .2/.2 | 0 | 2/2 | 2/1 | | 5/5 | | 20/20 | 60.0 | 29.0 | 1.0 |
| Adit #1 | 07/17/96 | Belmont Mine adit | Adit Discharge | | | 10 | 5 | 2330 | 0.2 | 100 | | 1 | | 5 | | 90 | | | |
| Adit #18 | 07/17/96 | Collapsed mine adit near the ski base area | Adit Discharge | | | 10 | 5 | 240 | 0.2 | 10 | | 1 | | 5 | | 40 | | | |
| Adit #2 | 07/17/96 | Belmont Mine adit | Adit Discharge | | | 10 | 5 | 60 | 0.2 | 10 | | 1 | | 5 | | 70 | | | |
| 25-024-AD1 | 6/23-24/94 | Drumlummon Mill; adit discharge on WR4 | Adit Discharge | 2.6 | 8.7 | 4.7 | 4.6 | 2140 | 0.11 | 1640 | 8.0 | 2.1 | 29.4 | | | 6.07 | | | |
| H8 | 08/27/81 | Maskelyne Tunnel discharge at culvert | Adit Discharge | <1 | | <20 | <10 | 1160 | <1 | 1700 | | <10 | | <5 | | 150 | 84 | 22 | 8 |
| H8 | 12/07/81 | Maskelyne Tunnel discharge at culvert | Adit Discharge | <1 | | <20 | 10 | 1430 | <.2 | 1860 | | <10 | | <5 | | 10 | 80 | 24 | 8 |
| H10 | 10/21/81 | Obie adit discharge | Adit Discharge | <1/<1 | | <20/<20 | <10/<10 | 60/<30 | <.2/<.2 | 20/20 | | <10/<10 | | <5/<5 | | 10/<10 | 53 | 6 | 2 |
| TP #1 | 10/06/83 | Tailings Pond Groundwater Monitoring System, Site #1 | Groundwater | | | | | | | | | | | | | | | | |
| TP #2 | 10/06/83 | Tailings Pond Groundwater Monitoring System, Site #2 | Groundwater | | | | | | <.2 | | | | | | | | 74 | 19 | 6 |
| TP #4 | 10/06/83 | Tailings Pond Groundwater Monitoring System, Site #4 | Groundwater | | | | | | <.2 | | | | | | | | 72 | 18 | 7 |
| TP #5 | 10/06/83 | Tailings Pond Groundwater Monitoring System, Site #5 | Groundwater | | | | | | 0.8 | | | | | | | | 70 | 18 | 6 |
| TP #1 SEEP | 11/16/83 | Seep near Tailings Pond Groundwater Monitoring System, Site #1 | Groundwater | | | | | | | | | | | | | | | | |
| W-8 | 12/13/83 | Robert O'Connell residence, Marysville | Groundwater | /<10 | | | /110 | /<30 | /<1 | /<20 | /<30 | /<10 | | /<5 | /<100 | /10 | 39 | 7 | 3 |
| W-22 | 12/13/83 | Thomas residence, Marysville | Groundwater | /<10 | | | /50 | /<30 | /<1 | /<20 | /<30 | /<10 | | /<5 | /<100 | /20 | | | |
| W-35 | 12/13/83 | Goldsil Mining and Milling, Inc., mill office supply well | Groundwater | /<10 | | | /<10 | /3100 | /<1 | /60 | /<30 | /<10 | | /<5 | /<100 | /<10 | | | |
| E MILLER | 10/21/81 | Emma Miller Mine (shaft) | Groundwater | <1/<1 | | <20/<20 | 10/10 | 60/<30 | <.2/<.2 | <20/<20 | | <10/<10 | | <5/<5 | | 10/10 | 43 | 4 | 2 |
| DRUMLUMMON | 01/08/82 | Drumlummon Mine No.1 shaft (28 ft. below water surface) | Groundwater | <1/<1 | | <20/<20 | 10/10 | 13900/60 | <.2/<.2 | 1850/1510 | | 50/<10 | | <5/<5 | | 20/20 | 81 | 25 | 8 |
| GW-1 | 9/2/87 | Sump connecting four wells near the upstream tailings pond | Groundwater | | | | | | 1.06 | | | | | | | | | | |
| Station #5 | 11/29/76 | Seep into Silver Creek between upper and lower tailings ponds | Groundwater | | | | | | | | | | | | | | | | |
| Station #5 | 01/12/77 | Seep into Silver Creek between upper and lower tailings ponds | Groundwater | <1 | | | <10 | 50 | | | <50 | | | | | 10 | | | |
| Station #5A | 01/26/77 | Seep into Silver Creek at lower tailings pond; western portion | Groundwater | <1 | | | <10 | 80 | | | <50 | | | | | <10 | | | |
| Station #5A | 01/31/77 | Seep into Silver Creek at lower tailings pond; western portion | Groundwater | | | | | | | | | | | | | | | | |
| Station #5B | 01/26/77 | Seep into Silver Creek at lower tailings pond; eastern portion | Groundwater | <1 | | | <10 | 140 | | | <50 | | | | | <10 | | | |
| Station #5B | 01/31/77 | Seep into Silver Creek at lower tailings pond; eastern portion | Groundwater | | | | | | | | | | | | | | | | |

Note: WQB-7 standards for metals in groundwater are based upon the dissolved portion of the sample (after filtration through a 0.45 um membrane filter)

**Table 3-13. Summary of Previous Silver Creek Drainage Groundwater and Adit Discharge Chemistry Results**

| Sample Station | Sample Date | Sample Location | Medium | K (mg/L) | Hardness (mg $CaCO_3$/L) | Total Suspended Solids (mg/L) | Total Dissolved Solids (mg/L) | Carbonate as $CO_3$ (mg/L) | Bicarbon-ate as $HCO_3$ (mg/L) | Total Alkalinity as $CaCO_3$ (mg/L) | Chloride (mg/L) | Sulfate (mg/L) | $NO_3/NO_2$-N (mg/L) | Total Cyanide (mg/L) | Source/Date |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | WQB-7 Ground Water Human Health Standard | Groundwater | | | | | | | | | | 10000 | | |
| PIPINICH 25-200-GW-1 | 10/11/95 | Pipinich Residence | Groundwater | 1.0 | 145.0 | | 195 | 0 | 167 | 137 | 1 | 19 | 0.62 | 0.005 | Maxim, 1996 |
| PIPINICH 25-200-GW-1 | 05/01/96 | Pipinich Residence | Groundwater | 2.0 | 158.0 | | 197 | 0 | 173 | 142 | 2 | 19 | 0.98 | 0.005 | Maxim, 1996 |
| HULL 25-200-GW-2 | 10/11/95 | Hull Residence | Groundwater | 1.0 | 146.0 | | 195 | 0 | 167 | 137 | 1 | 11 | 0.08 | 0.005 | Maxim, 1996 |
| HULL 25-200-GW-2 | 05/01/96 | Hull Residence | Groundwater | 2.0 | 140.0 | | 176 | 0 | 167 | 137 | 2 | 10 | 0.13 | 0.005 | Maxim, 1996 |
| M-VILLE 25-200-GW-3 | 10/11/95 | Marysville House | Groundwater | 1.0 | 81.0 | | 140 | 0 | 101 | 83 | 3 | 23 | 1.30 | 0.005 | Maxim, 1996 |
| HALL 25-200-GW-4 | 10/11/95 | Hall Residence | Groundwater | 1.0 | 7.0 | | 175 | 0 | 104 | 85 | 7 | 24 | 3.48 | 0.005 | Maxim, 1996 |
| HALL 25-200-GW-4 | 05/01/96 | Hall Residence | Groundwater | 1.0 | 7.0 | | 138 | 0 | 93 | 76 | 2 | 17 | 2.00 | 0.005 | Maxim, 1996 |
| 25-200-PS-01 | 10/11/95 | Bald Mountain (at culvert below ski area parking lot) | Adit Discharge | 1.0 | 119 | | 160 | 0 | 129 | 106 | 2 | 19 | 1.22 | 0.005 | Maxim, 1996 |
| 25-200-PS-01 | 02/08/96 | Bald Mountain (at culvert below ski area parking lot) | Adit Discharge | 1.0 | 124 | | 145 | 0 | 127 | 104 | 1 | 19 | 1.18 | 0.005 | Maxim, 1996 |
| 25-200-PS-01 | 05/01/96 | Bald Mountain (at culvert below ski area parking lot) | Adit Discharge | 2.0 | 118 | | 157 | 0 | 133 | 109 | 1 | 22 | | 0.005 | Maxim, 1996 |
| 25-200-PS-01A | 10/11/95 | Bald Mountain (at black pipe draining adit to storage tank) | Adit Discharge | 1.0 | 114 | | 142 | 0 | 123 | 101 | 1 | 15 | 0.78 | 0.014 | Maxim, 1996 |
| 25-200-PS-02 | 10/11/95 | Drumlummon adit | Adit Discharge | 3.0 | 280 | | 326 | 0 | 349 | 286 | 2 | 14 | 0.01 | 0.005 | Maxim, 1996 |
| 25-200-PS-02 | 02/08/96 | Drumlummon adit | Adit Discharge | 5.0 | 287 | | 306 | 0 | 339 | 278 | 2 | 12 | 0.19 | 0.005 | Maxim, 1996 |
| 25-200-PS-02 | 05/01/96 | Drumlummon adit | Adit Discharge | 4.0 | 269 | | 319 | 0 | 317 | 260 | 2 | 20 | 0.03 | 0.005 | Maxim, 1996 |
| Adit #1 | 07/17/96 | Belmont Mine adit | Adit Discharge | | | | 171 | | | | | | | | Maxim, 1996 |
| Adit #18 | 07/17/96 | Collapsed mine adit near the ski base area | Adit Discharge | | | | 162 | | | | | | | | Maxim, 1996 |
| Adit #2 | 07/17/96 | Belmont Mine adit | Adit Discharge | | | | 142 | | | | | | | | Maxim, 1996 |
| 25-024-AD1 | 6/23-24/94 | Drumlummon Mill; adit discharge on WR4 | Adit Discharge | | 319 | | 309 | | | | <5 | 24 | <0.05 | | MDSL/AMRB, 1995 |
| H8 | 08/27/81 | Maskelyne Tunnel discharge at culvert | Adit Discharge | 4 | 296 | 3 | 312 | 0 | 346 | 284 | 6 | 15 | | | Goldsil Mining and Milling, Inc., 1984a |
| H8 | 12/07/81 | Maskelyne Tunnel discharge at culvert | Adit Discharge | 4 | 295 | 14 | 317 | 0 | 368 | 302 | 14 | 3 | | | Goldsil Mining and Milling, Inc., 1984a |
| H10 | 10/21/81 | Obie adit discharge | Adit Discharge | 2 | 154 | <1 | 172 | 0 | 169 | 139 | 23 | 2 | | | Goldsil Mining and Milling, Inc., 1984a |
| TP #1 | 10/06/83 | Tailings Pond Groundwater Monitoring System, Site #1 | Groundwater | | | | | | | | | | | 0.005 | Hydrometrics, 1983 |
| TP #2 | 10/06/83 | Tailings Pond Groundwater Monitoring System, Site #2 | Groundwater | | | | | | 288 | | 2 | 26 | | <0.005 | Hydrometrics, 1983 |
| TP #4 | 10/06/83 | Tailings Pond Groundwater Monitoring System, Site #4 | Groundwater | | | | | | 272 | | 2 | 26 | | <0.005 | Hydrometrics, 1983 |
| TP #5 | 10/06/83 | Tailings Pond Groundwater Monitoring System, Site #5 | Groundwater | | | | | | 269 | | 2 | 25 | | <0.005 | Hydrometrics, 1983 |
| TP #1 SEEP | 11/16/83 | Seep near Tailings Pond Groundwater Monitoring System, Site #1 | Groundwater | | | | | | | | | | | 0.005 | Hydrometrics, 1983 |
| W-8 | 12/13/83 | Robert O'Connell residence, Marysville | Groundwater | <1 | 128 | | 142 | 0 | 133 | 109 | 1 | 24 | 0.14 | | Hydrometrics, 1983 |
| W-22 | 12/13/83 | Thomas residence, Marysville | Groundwater | | | | | | | | | | | | Hydrometrics, 1983 |
| W-35 | 12/13/83 | Goldsil Mining and Milling, Inc., mill office supply well | Groundwater | | | | | | | | | | | | Hydrometrics, 1983 |
| E MILLER | 10/21/81 | Emma Miller Mine (shaft) | Groundwater | 2 | 124 | <1 | 142 | 0 | 135 | 110 | 22 | 1 | | | Goldsil Mining and Milling, Inc., 1984a |
| DRUMLUMMON | 01/08/82 | Drumlummon Mine No.1 shaft (28 ft. below water surface) | Groundwater | 5 | 302 | 13 | 314 | 0 | 372 | 305 | 2 | 8 | | | Goldsil Mining and Milling, Inc., 1984a |
| GW-1 | 9/2/87 | Sump connecting four wells near the upstream tailings pond | Groundwater | | | | | | | | | | | ND | MDHES, 1988 |
| Station #5 | 11/29/76 | Seep into Silver Creek between upper and lower tailings ponds | Groundwater | | | | | | | | | | | 0.65 | MT Dept. of Fish and Game, 1977 |
| Station #5 | 01/12/77 | Seep into Silver Creek between upper and lower tailings ponds | Groundwater | | | | | | | | | | | 0.050 | MT Dept. of Fish and Game, 1977 |
| Station #5A | 01/26/77 | Seep into Silver Creek at lower tailings pond; western portion | Groundwater | | | | | | | | | | | | MT Dept. of Fish and Game, 1977 |
| Station #5A | 01/31/77 | Seep into Silver Creek at lower tailings pond; western portion | Groundwater | | | | | | | | | | | 0.41 | MT Dept. of Fish and Game, 1977 |
| Station #5B | 01/26/77 | Seep into Silver Creek at lower tailings pond; eastern portion | Groundwater | | | | | | | | | | | | MT Dept. of Fish and Game, 1977 |
| Station #5B | 01/31/77 | Seep into Silver Creek at lower tailings pond; eastern portion | Groundwater | | | | | | | | | | | 0.18 | MT Dept. of Fish and Game, 1977 |

Note: WQB-7 standards for metals in groundwater are based upon the dissolved portion of the sample (after filtration through a 0.45 um membrane filter)




| NO. | REVISION DESCRIPTION | BY | DATE | DESIGN: | DRAWN: KSR | CHECKED: CRS |
|---|---|---|---|---|---|---|
| | | | | APPROVED: | DATE: 4/2003 | JOB NO: A1348 |
| | | | | SCALE: AS SHOWN | FILENAME: A1348GT.dwg | |

MONTANA DEQ/MINE WASTE CLEANUP BUREAU
SILVER CREEK DRAINAGE PROJECT
LEWIS & CLARK COUNTY, MONTANA

Olympus Technical Services, Inc.

GOLDSIL TAILINGS
MONITORING WELL LOCATION MAP
AND POTENTIOMETRIC SURFACE

FIGURE
3-19

The monitoring wells were surveyed on November 22, 2002. Table 3-14 summarizes the monitoring well survey and static water level measurements. A potentiometric map of the groundwater surface based on the December 4, 2002 static water level measurements is presented in Figure 3-19. The shallow groundwater flow direction is North 68° East at a gradient of 0.043 feet per foot. In this area, the shallow groundwater flow direction generally parallels the flow of Silver Creek.

Water samples were collected from the four monitoring wells on December 4, 2002 after purging at least three well volumes and achieving stable field parameters for pH, temperature and specific conductivity. In addition, a shallow groundwater sample was collected on June 12, 2002 from a 2 feet diameter, covered steel drum located near the northeastern corner of the lined tailings pond. This steel drum acts as collection point for 5 shallow PVC monitoring wells or piezometers located immediately north of and along the toe of the lined tailings pond. Water was overflowing the sump and discharging to the Silver Creek floodplain.

Water quality samples (MW1, MW2, MW3 and MW4) and quality control samples (MW5 and MW6) collected from the shallow monitoring wells were sent to Energy Laboratories, Inc. in Billings, MT where they were analyzed for total recoverable and dissolved concentrations for the following analytes: Ag, As, Ba, Cd, Cr, Cu, Fe, Hg, Mn, Ni, Pb, Sb and Zn. In addition to the metal/metalloid analyses, pH, total cyanide, total dissolved solids (TDS), sulfate, nitrate + nitrite as N, and chloride analyses were done. The water quality sample from the sump area (25-365-GW1) was collected and analyzed by Energy Laboratories, Inc. during the Phase I site characterization and was run for the same analyte suite (excluding dissolved metal/metalloid concentrations) as the monitoring well samples. The analytical results are summarized in Table 3-15. It is readily apparent from the shallow aquifer sampling results that elevated water quality concentrations are almost exclusively associated with the total recoverable metal verses the dissolved metal concentrations. The only exception is the detection of Ag and Hg (although neither concentration exceeded Montana groundwater standards) in water collected from monitoring well MW-4. This suggests that anomalous concentrations of target analytes are likely related to suspended sediment in the water samples. Based on the elevated iron and manganese concentrations present in all four wells, it is possible that detected total recoverable metals are complexed with one or both of these metals.

Federal safe drinking water act (SDWA) standards for groundwater are based on total recoverable metal concentrations whereas Montana human health standards (HHS) are based on dissolved metal concentrations. The wells and analytes which were equal to or exceeded total recoverable metal concentrations for primary and secondary Federal SDWA standards included: MW-1 (Fe 1,930 ug/L; Mn 60 ug/L); MW-2 (As 107 ug/L; Fe 5,350 ug/L; Mn 180 ug/L); MW-3 (As 65 ug/L; Fe 8.850 ug/L; Mn 1,380 ug/L; TDS 580 mg/L); MW-4 (Fe 2,470 ug/L; Hg 11 ug/L; Mn 100 ug/L). Other than the MW-4 Hg concentration being equal to the groundwater standard, no Montana HHS were exceeded in the dissolved metal concentrations.

The sump water quality sample (25-365-GW-1) results equaled or exceeded primary Federal SDWA maximum contaminant levels for Ag (350 ug/L), Fe (4,140 ug/L), Hg (7 ug/L), and Mn (2,230 ug/L). The elevated parameters in the sump water are generally consistent with the elevated parameters in the nearby monitoring well MW-4 except the concentrations for Ag, As, Fe, and Mn are significantly higher in the sump water. This may be related to seasonal variation due to the fact that the sump sample was collected during late spring conditions. During this period, the water level is increased in the leaking lined tailings pond because of precipitation and spring runoff events. The chemistry of the Goldsil mill vat tailings, the source of the tailings

## Table 3-14. Monitoring Well Survey and Static Water Level Measurement Results

| WELL ID | Northing | Easting | Top of Casing (TOC) Elev. (Ft.) | | Static Water Level Below TOC (Ft.) | Ground Water Elev. (Ft.) | Static Water Level Below TOC (Ft.) | Ground Water Elev. (Ft.) |
|---|---|---|---|---|---|---|---|---|
| | | | | **Date** | 11/25/2002 | 11/25/2002 | 12/4/2002 | 12/4/2002 |
| MW-1 | 49824.68 | 50402.62 | 4583.310 | | 19.0 | 4564.31 | 19.08 | 4564.23 |
| MW-2 | 49988.81 | 51007.59 | 4563.336 | | 25.3 | 4538.04 | 25.72 | 4537.62 |
| MW-3 | 50094.25 | 49774.79 | 4587.126 | | 14.0 | 4573.13 | 14.43 | 4572.70 |
| MW-4 | 50220.68 | 50605.45 | 4565.016 | | 15.0 | 4550.02 | 14.86 | 4550.16 |

**Table 3-15. Laboratory Chemistry Results For Groundwater**

**Total Recoverable Metals**

| Sample ID | Ag (ug/L) | As (ug/L) | Ba (ug/L) | Cd (ug/L) | Cr (ug/L) | Cu (ug/L) | Fe (ug/L) | Hg (ug/L) | Mn (ug/L) | Ni (ug/L) | Pb (ug/L) | Sb (ug/L) | Zn (ug/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MW-1 | <5 | 33 | <100 | <1 | <10 | <10 | 1930 | <0.1 | 60 | <10 | 10 | <5 | 20 |
| MW-2 | <5 | 107 | 100 | <1 | <10 | 10 | 5350 | 0.2 | 180 | <10 | 7 | <5 | 50 |
| MW-3 | 12 | 65 | 300 | <1 | <10 | 70 | 8850 | 1.5 | 1380 | <10 | 14 | <5 | 50 |
| MW-4 | 66 | 5 | 100 | <1 | <10 | 40 | 2470 | 11 | 100 | <10 | 3 | <5 | 10 |
| MW-5 | <5 | <3 | <100 | <1 | <10 | <10 | <30 | <1 | <10 | <10 | <2 | <5 | <10 |
| MW-6 | <5 | 109 | 100 | <1 | <10 | 10 | 5110 | 0.2 | 180 | <10 | 7 | <5 | 50 |
| 25-365-GW-1 | 350 | 22 | 200 | 2 | <10 | 190 | 4140 | 7 | 2230 | 10 | <10 | <50 | 20 |
| **Federal MCL** | - | 50 | 2000 | 5 | - | 1300 | 300 | 2 | 50 | 100 | 15 | 6 | 5000 |

**Dissolved Metals**

| Sample ID | Ag (ug/L) | As (ug/L) | Ba (ug/L) | Cd (ug/L) | Cr (ug/L) | Cu (ug/L) | Fe (ug/L) | Hg (ug/L) | Mn (ug/L) | Ni (ug/L) | Pb (ug/L) | Sb (ug/L) | Zn (ug/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MW-1 | <5 | <3 | <100 | <1 | <10 | <10 | <30 | <1 | <10 | <10 | <2 | <30 | <10 |
| MW-2 | <5 | <3 | <100 | <1 | <10 | <10 | <30 | <1 | <10 | <10 | <2 | <30 | <10 |
| MW-3 | <5 | <3 | <100 | <1 | <10 | <10 | <30 | <1 | <10 | <10 | <2 | <30 | <10 |
| MW-4 | 7 | <3 | <100 | <1 | <10 | <10 | <30 | 2 | <10 | <10 | <2 | <30 | <10 |
| MW-5 | <5 | <3 | <100 | <1 | <10 | <10 | <30 | <1 | <10 | <10 | <2 | <30 | <10 |
| MW-6 | <5 | <3 | <100 | <1 | <10 | <10 | <30 | <1 | <10 | <10 | <2 | <30 | 10 |
| **Montana HHS** | 35 | 20 | 2000 | 5 | - | 1300 | - | 2 | - | 100 | 15 | 6 | 2100 |

**Ground Water Wet Chemistry Results**

| Sample ID | pH (SU) | TDS (mg/L) | Sulfate (mg/L) | Chloride (mg/L) | Nitrate + Nitrite as N (mg/L) | Cyanide (mg/L) |
|---|---|---|---|---|---|---|
| MW-1 | 7.6 | 272 | 20 | 3 | 0.11 | <0.005 |
| MW-2 | 7.7 | 199 | 26 | <1 | 0.14 | <0.005 |
| MW-3 | 7.5 | 580 | 23 | 2 | 0.38 | <0.005 |
| MW-4 | 7.6 | 220 | 21 | 2 | 0.28 | <0.005 |
| MW-5 | 5.8 | <10 | 16 | <1 | <0.05 | <0.005 |
| MW-6 | 7.6 | 221 | 24 | 2 | 0.12 | <0.005 |
| 25-365-GW-1 | 6.8 | 260 | 24 | 3 | 0.63 | <0.005 |
| **Federal MCL** | 6.5-8.5 | 500 | 250 | 250 | 10 | 0.2 |

**Ground Water Field Measurements**

| Sample ID | pH (SU) | Temp (°C) | SC (mS) | SWL (Ft. Below TOC) |
|---|---|---|---|---|
| MW-1 | 8.1 | 6.5 | 0.36 | 19.08 |
| MW-2 | 7.7 | 5.2 | 0.48 | 25.72 |
| MW-3 | 8.1 | 5.8 | 0.39 | 14.43 |
| MW-4 | 7.7 | 6.4 | 0.40 | 14.86 |
| 25-365-GW-1 | 7.6 | | | |

**LEGEND**

| | | |
|---|---|---|
| MW-1 | 12/4/2002 | Sample collected from monitoring well MW1 located south of southwest corner of the lined tailings pond immediately south of east-west access road |
| MW-2 | 12/4/2002 | Sample collected from monitoring well MW2 located to the east of the lined tailings pond and west of the Goldsil Mill site |
| MW-3 | 12/4/2002 | Sample collected from monitoring well MW3 located in the southwest corner of the Goldsil Tailings open pit mine |
| MW-4 | 12/4/2002 | Sample collected from monitoring well MW4 located near the center of the lower bench of the lined tailings pond |
| MW-5 | 12/4/2002 | Field blank sample |
| MW-6 | 12/4/2002 | Duplicate sample of MW2 |
| 25-365-GW-1 | 6/12/2002 | Sample collected from 2 feet diameter, covered steel drum located near the northeastern corner of lined tailings pond; acts as collection point for 5 shallow PVC monitoring wells (piezometers?) located immediately north of and along the toe of the tailings pond |

Federal MCL - Federal primary and secondary maximum contaminant level based on total recoverable metal concentration; Drinking Water Standards and Health Advisories, EPA October 1996

Montana HHS - Montana human health standard based on dissolved metal concentration; Circular WQB-7 Montana Numeric Water Quality Standards, January 2002 that were deposited into the lined tailings impoundment, is consistent with the elevated parameters in the sump water. Higher water levels in the pond would contribute to higher head and the potential for increased leakage through the damaged liner. The tailings impoundment would thus provide an additional source of contaminant loading into the shallow alluvial aquifer under high flow conditions that may not be as significant during low flow conditions.

## 3.9 ASSESSMENT OF AIRBORNE PARTICULATE EMISSIONS

The principal waste sources in the Silver Creek Drainage Project area are the mill tailings, placer tailings and waste rock piles. Placer tailings and waste rock pile gradations are typically coarse grained containing abundant rock material. These waste sources thus contain lesser fine sediment that could be a source for airborne particulate emissions. The mill tailings typically are very fine grained to fine grained and consist of silt, sand and clay. The near surface tailings commonly exhibit floury textures which when disturbed create dust emissions. Although the mill tailings are generally moderately well vegetated, they do have areas of exposed tailings with little to no vegetation cover. Laboratory chemistry results for composite tailings indicate that mercury (Hg) and total cyanide would be the principal contaminants of concern for airborne particulate emissions. Table 3-16 summarizes the concentrations of Hg and total cyanide for the different mill tailings areas.

The common base metals Cu, Pb and Zn are present in low concentrations in the mill tailings. The combined base metal concentrations in mill tailings range from 124 mg/Kg to 1257 mg/Kg. Other potential airborne contaminants of concern, including As and Cd, also have limited potential for creating airborne particulate emissions problems because of low concentration. Arsenic and Cd maximum concentrations in the mill tailings are 54 mg/Kg and 4 mg/Kg, respectively.

**TABLE 3-16 SUMMARY OF MERCURY AND TOTAL CYANIDE CONCENTRATIONS IN MILL TAILINGS**

| Tailings Area | Range of Hg (mg/Kg) | Range of Total Cyanide (mg/Kg) |
|---|---|---|
| Goldsil tailings | 18 to 96 | <0.5 to 21.1 |
| Drumlummon tailings | <1 to 1 | <0.5 |
| Drumlummon millsite tailings | 1 to 9 | <0.2 to 24.8 |
| Upper Pond Area tailings | 32 to 140 | 0.5 to 1 |
| Middle Pond Area tailings | 7 to 26 | 4.1 to 23.9 |
| Lower Pond Area tailings | 27 to 37 | 2.0 to 5.0 |

The mill tailings areas which are the most accessible include the Goldsil tailings, the Upper Pond Area and the Lower Pond Area. Secondary roads, accessible from the Marysville Road through unlocked gates, provide easy access to these areas. The other tailings areas are not as readily accessible for they have limited road access and are generally moderately to well vegetated.

## 3.10 ASSESSMENT OF PHYSICAL HAZARDS

The principal physical hazards in the Silver Creek Drainage Project are associated with the Drumlummon mine and millsite areas. The mill tailings areas have few physical hazards. The following sections summarize the physical hazards identified in the project area.

### 3.10.1 Drumlummon Mine Area

Although numerous adits and shafts were constructed in the Drumlummon mine area, most do not pose significant physical hazards for they have been secured via metal grates or natural collapse. The shafts located near WR2 and at the road intersection northeast of WR2 are both grated over. The only shaft areas identified that pose a physical hazard are an open decline and a partially collapsed shaft. The open decline shaft near the hoist house area north of WR1 is only secured by a barbed-wire fence that surrounds it. The shaft appears to be open to the underground workings. The partially collapsed shaft north of the largest open cut pit is fenced but the fact that it is only partially collapsed, does not limit a vertical fall into the underground workings. The adits identified in the mine area do not appear to pose a threat because the portal areas are collapsed enough to safeguard them from any access. The most significant physical hazard in the mine area is a series of large open cut pits with very steep highwalls on the upslope side. The upslope area is heavily forested and no fencing and only limited signs are present to warn of the highwall hazard. These highwalls also pose rock fall hazards for persons entering the pit areas.

### 3.10.2 Drumlummon Millsite Area

The Drumlummon millsite area contains two large waste rock piles that are essentially steep, scree slopes with no vegetation. These waste rock piles would only constitute a physical hazard to someone who may try to traverse the steep face. The main haulage level adit portal for the Drumlummon underground mine occurs near the south end of waste rock pile WR4. This adit has a door which no longer limits access to the haulage level mine tunnel. The door has been vandalized in that the lock is gone and the hinges have been pried open. The only other physical hazard present is a partially collapsed adit that is still accessible directly south of the Drumlummon mill foundation. The portal has an opening 3 feet high by 5 feet wide.

### 3.10.3 Mill Tailings Areas

Few physical hazards are present in the mill tailings areas. The Argo millsite that reportedly was used for reprocessing of mill tailings via cyanide vat leaching contains only ore storage bins and wooden debris. No vat leach tanks are left at the site. The ore storage bins are still standing and do not appear to pose a significant threat of collapse. The wood debris piles may contain rusty nails.

A boneyard located to the southeast of the lined tailings pond area (Figure 3-6) contains cyanide drums which appear to be empty, but may contain residual chemical. The boneyard also contains metal beams, metal siding, insulation, tires and miscellaneous solid waste. which does not appear to constitute a significant physical hazard. A second boneyard area (Figure 3-6) is located at the west end of the Goldsil Ramp tailings and contains similar debris materials. A small solid waste pit is located north off the former Goldsil mill (Figure 3-6). This area appears to have been a pond and the lined ditch that is north of the mill appears to have terminated at this pond. The west end of the pond appears to have been removed and the pit has been partially filled with solid waste and debris. The pit contains wood and metal debris, tires, some batteries, PVC pipe and fiberglass insulation. The pit also contains a small amount of mill tailings.

The open pit mine, approximately 600 feet west of the lined tailings pond, in the main Goldsil tailings contains some near vertical cut walls that are 25 feet high. These highwalls are physical hazards in that they pose a fall hazard and collapse hazard.

### 3.10.4 Other Potential Physical Hazard Areas

A fenced shaft was observed on the hillside northeast of the confluence of Jennies Fork and Silver Creek. The shaft is enclosed by a barbed-wire fence and warning signs. The shaft area is located on the knob of a steep hillside and does not appear to be accessed by the general public. The fence and signs should provide adequate warning of the hazard for hikers or other passersby.

During the Shannon Mine reconnaissance, Olympus observed three other abandoned mines, believed to be the Ample/Hickey, Allegheny and Emma Miller (according to GIS records obtained through Montana Natural Resource Information System (NRIS)), along the Ottawa Gulch Road between the Shannon Mine and Marysville. The Emma Miller is located just on the north side of Ottawa Gulch Road. There is a small wood structure partially covering a shaft that is visible from the road. The building and shaft are enclosed by a barbed-wire fence, however, the shaft appears to be open and may, in spite of the fence, be a safety hazard. Warning signs on the fence are riddled with bullet holes and are no longer readable. Since the site is located near the main access road to this area, Olympus recommends that this site, along with the Ample/Hickey and Allegheny be further evaluated as potential safety hazards.

### 3.10.5 Other Potential Mining-Related Activity

During the Phase I reconnaissance, three other suspected tailings areas were identified and sampled for XRF screening. The first suspected tailings area is a small pile located adjacent to a placer tailings pile on the north side of Silver Creek between stream sediment samples SE23 and SE24. The material encountered was a light tan, uniform sandy silt material that is similar in appearance to tailings observed in the Silver Creek Drainage Project area. Sample XRF-1 was collected and screened for a multi-element suite using a portable XRF analyzer. The location of sample XRF-1 is shown on Figure 3-16b. The suspected tailings material is located above the Drumlummon tailings, which are reported to have been reprocessed in the past. This small pile, estimated at less than 20 cubic yards, may have been displaced to its location during removal operations for reprocessing of the tailings.

The second suspected tailings area is located along the hillside south side of Silver Creek between the Drumlummon and Goldsil tailings areas. The material encountered was a light tan, uniform sandy silt material and sample XRF-2 was collected and screened for a multi-element suite using a portable XRF analyzer. The location of sample XRF-2 is shown on Figure 3-16b. The suspected tailings were found on a bench above the south edge of the Silver Creek floodplain. The bench ranges from about 4 to 8 feet wide and is about 6 feet high. The bench was followed eastward and it ends at the western-most end of the Goldsil tailings pile.

Suspected tailings material was observed at various locations along the bench. Remnants of an old ditch were observed along portions of the bench. Although no evidence of any infrastructure was observed, it appears that the bench could have been part of a tailings conveyance system, such as discharge pipe or wooden flume. The tailings could have been deposited from spillage from a tailings conveyance system. The length of the bench is approximately 900 feet, although suspected tailings were not observed continuously along this length. Based on an average width of 6 feet and an estimated depth of 2 feet, a conservative estimate of the tailings volume is 400 cubic yards. Since suspected tailings were not observed in all areas of the bench, the actual volume is probably less.

The third suspected tailings area observed during the reconnaissance is on the north side of Silver Creek, downstream from the Goldsil millsite and approximately 50 feet north of stream sediment sample SE-52. The material encountered was a white to light gray, uniform sandy silt material. Sample XRF-3 was collected from the suspected tailings material and screened for a multi-element suite using a portable XRF analyzer. The location of sample XRF-3 is shown on Figure 3-16b. The suspected tailings material is located in a depression to the north of a pond behind a man-made dam with a beaver dam spillway. The suspected tailings material is mostly void of vegetation, while the surrounding area is well vegetated with grasses. The area is circular with an estimated 30 foot diameter. The material was most likely deposited as flood-washed tailings from an upstream source and appears to be relatively thin. The estimated volume is less than 30 cubic yards.

The XRF data were used to evaluate whether these materials are tailings. The sum of the XRF copper, lead and zinc concentrations (XRF Cu+Pb+Zn) were used as a statistic to compare with the XRF results from the waste sources evaluated in the Phase I and Phase II site characterization activities. Table 3-17 provides summary statistics for XRF Cu+Pb+Zn from waste sources evaluated during Phase I and II of the Silver Creek Drainage Project. In the background samples, the XRF Cu, Pb and Zn were generally less than detection limits and the average and maximum XRF Cu+Pb+Zn concentrations were 7.2 ppm and 43 ppm, respectively. The placer tailings and borrow source samples, which both consisted of unprocessed placer tailings overburden, had average XRF Cu+Pb+Zn concentrations ranging from 67.9 to 83.1 ppm and maximum concentrations ranging from 272 to 289 ppm, respectively. XRF Cu+Pb+Zn concentrations from the Drumlummon, Goldsil, and Upper, Middle and Lower Pond tailings sources had average XRF Cu+Pb+Zn concentrations ranging from 140.8 to 703.8 ppm, respectively, and maximum concentrations ranging from 351 to 1753 ppm, respectively.

The XRF Cu+Pb+Zn concentrations for samples XRF-1, XRF-2 and XRF-3 were 660, 788 and 307 ppm, respectively. These concentrations are in the range found in the known tailings sources and are significantly above both the average and maximum concentrations found in the background, unprocessed placer tailings overburden and borrow source samples. Therefore, it is concluded that these suspected tailings sources are indeed tailings.

During the Phase I reconnaissance, a set of five vat tanks, including two wood and three metal, were discovered approximately 450 feet west of Birdseye Road (Figure 1-8). The vat tanks are located on the hillside north of Silver Creek. The tanks are arranged on two different levels. The upper level consists of the two wood vat tanks and one metal tank. The lower level includes the two remaining metal tanks. The tanks are approximately 15 feet in diameter. The three metal tanks are all empty, however, the two wooden tanks are approximately ¾ full of soil material. In addition to the tanks, there is dilapidated wood framing and assorted piping that indicates that this was some type of processing facility. The piping is configured such that the tanks on the upper level would drain into the tanks on the lower level. Given its location at the lower end of the large placer tailings area, it is reasonable to conclude that the facility was likely related to processing of placer tailings.

**TABLE 3-17 SUMMARY STATISTICS FOR XRF CU+PB+ZN FOR SILVER CREEK DRAINAGE PROJECT PHASE I AND PHASE II WASTE SOURCES**

| Source Type | Maximum XRF Cu+ Pb+Zn (ppm) | Minimum XRF Cu+ Pb+Zn (ppm) | Average XRF Cu+ Pb+Zn (ppm) | Median XRF Cu+ Pb+Zn (ppm) | No. Samples |
|---|---|---|---|---|---|
| Waste Rock | 763 | 15 | 191.6 | 102 | 8 |
| Drumlummon Tailings | 351 | 25 | 140.8 | 126 | 31 |
| Goldsil Tailings | 1049 | 79 | 512.1 | 475 | 108 |
| Goldsil Millsite | 810 | 100 | 407.2 | 373 | 26 |
| Upper Pond | 1753 | 47 | 703.8 | 543 | 25 |
| Middle Pond | 425 | 43 | 255.3 | 281 | 18 |
| Lower Pond | 811 | 206 | 427.4 | 389.2 | 21 |
| Stream Sediment | 552 | 20 | 210.1 | 203 | 127 |
| Borrow Source | 272 | 0 | 83.1 | 64 | 11 |
| Placer Tailings | 289 | 0 | 67.9 | 49 | 35 |
| Background | 43 | 0 | 7.2 | 0 | 6 |

To characterize the soil material, shovel and hand auger pits were excavated in the soil material in the wooden vat tanks. Four shovel pit/auger holes were excavated in each of the wooden vat tanks. The material encountered in the vats is a fine sand with gravel, and was very dry. Because of the fine, dry nature of the sand, it would flow readily, making it difficult to keep the holes open to sample. The holes were excavated to depths of 2 to 2.5 feet and samples were collected. One four-point composite sample was collected from each tank and was screened for a multi-element suite using a portable XRF analyzer. The Vat Tank sediment XRF concentration range results for the principal elements of interest are as follows: Ag (no detection), As (49-61 ppm), Ba (817-858 ppm), Cd (no detection), Cr (no detection), Cu (no detection), Fe (7,550-7,560 ppm), Hg (no detection), Mn (no detection), Ni (no detection), Pb (36-62 ppm), Sb (57-69 ppm), and Zn (229-263 ppm). A single composite sample (25-SCD-VAT), comprised of material from both vat tank samples was analyzed by Energy Laboratories for arsenic, cadmium, copper, lead, mercury, zinc, total cyanide and paste pH. The laboratory sample result is presented below:

| Sample ID | As (mg/Kg) | Cd (mg/Kg) | Cu (mg/Kg) | Pb (mg/Kg) | Hg (mg/Kg) | Zn (mg/Kg) | CN (mg/Kg) | Paste pH |
|---|---|---|---|---|---|---|---|---|
| 25-SCD-VAT | 20 | <1 | 76 | 72 | 12 | 210 | <0.05 | 7.8 |

The following are the laboratory concentrations for each element analyzed in the vat composite sample relative to the mean background soil concentration: As (0.8x), Cu (2.2x), Pb (6.35x), Hg (>24x) and Zn (3.1x). Based on this evaluation, lead, mercury and zinc are significantly elevated above background, although overall lead and zinc concentrations are relatively low compared to many abandoned mine sites. The laboratory results also indicate that cyanide was not used for processing in this area. The presence of elevated mercury supports the probability that this was a placer mine processing operation.

Little evidence of mining activity was observed below Birdseye Road. The only real evidence was a shallow adit in the alluvial gravels on the Talley property in the SE ¼ Section 16, Township 11 North, Range 4 West (Figure 1-11). The adit consists of a wood frame structure at the opening that is mostly covered with brush. The adit is collapsed above the wood structure. The adit is on the south side of Silver Creek and the opening is less than 5 feet vertically above the creek elevation. A trickle of water was observed flowing from the adit opening and traveling approximately 50 feet to enter Silver Creek. No waste rock pile was observed in the area of the adit, suggesting that there were limited workings. The adit is currently not accessible and should not represent a significant safety hazard.

The only other possible evidence of mining-related activity observed below Birdseye Road is a building located on the Gehring property (Figure 1-10). This area was not characterized because the land owner access agreement was not executed. A multi-tiered building with classic mill-style architecture was observed on this property from Lincoln Road. The building is located on a terrace on the south side of Silver Creek near the railroad line. Aerial photograph interpretation of Figure 1-10 indicates that there has been ground disturbance in the vicinity of the building in a linear pattern that extends toward the railroad line.

In addition to the features that Olympus observed in the Silver Creek Drainage Project area, records at the DEQ-MWCB indicate that there is a suspected tailings impoundment and buried solid waste near the Silver Fox Minor subdivision. The impoundment and solid waste were noted in a memorandum dated August 5, 1999 to the Board of County Commissioners from the Lewis and Clark County Planning Department. According to the memorandum and a map of the proposed subdivision, the subdivision is located in the South ½ of Section 6 and the North ½ of Section 7, Township 11 North, Range 4 West (DEQ-MWCB/Olympus, 2003a).

Photographs of the suspected tailings impoundment were taken by the DEQ-MWCB in August 1999 (DEQ-MWCB/Olympus, 2003a). The DEQ-MWCB photographs and the map show that the impoundment is located near the railroad along the south side of Silver Creek. Based on these location descriptions, the impoundment is located just downstream of stream sediment sample SE-94. This is within the area where sampling was not completed because landowner access agreements had not been executed. The DEQ-MWCB photographs show light-colored, fined-grained material on the surface of the impoundment that could be tailings material.

A sample from the tailings impoundment was collected by the developer and analyzed for total metals in August 1999. The sample was reportedly collected from five sample holes equally proportioned across the impoundment area. The top 2.5 to 3 feet of soil were reported as a dark loam. The samples were reportedly collected from a depth of 2.5 to 3.5 feet, and they had the appearance of mill tailings. The laboratory report and a description of the sample locations are provided in the Phase I site characterization report (DEQ-MWCB/Olympus, 2003a). The sample results are summarized in Table 3-18.

## 3.11 POTENTIAL REPOSITORY SITE INVESTIGATION

### 3.11.1 Goldsil Tailings Repository

Silver Creek and its floodplain are located in a steep, narrow, mountainous drainage basin where the land ownership is almost exclusively private. The potential areas for mine/mill waste repositories are limited. During the Phase II site characterization, a potential mine/mill waste repository site near the central portion of the Goldsil tailings area was investigated. This work involved assessing land ownership, estimating potential repository storage volume and preliminary design, construction logistics, and an evaluation of the subsurface geology and shallow groundwater.

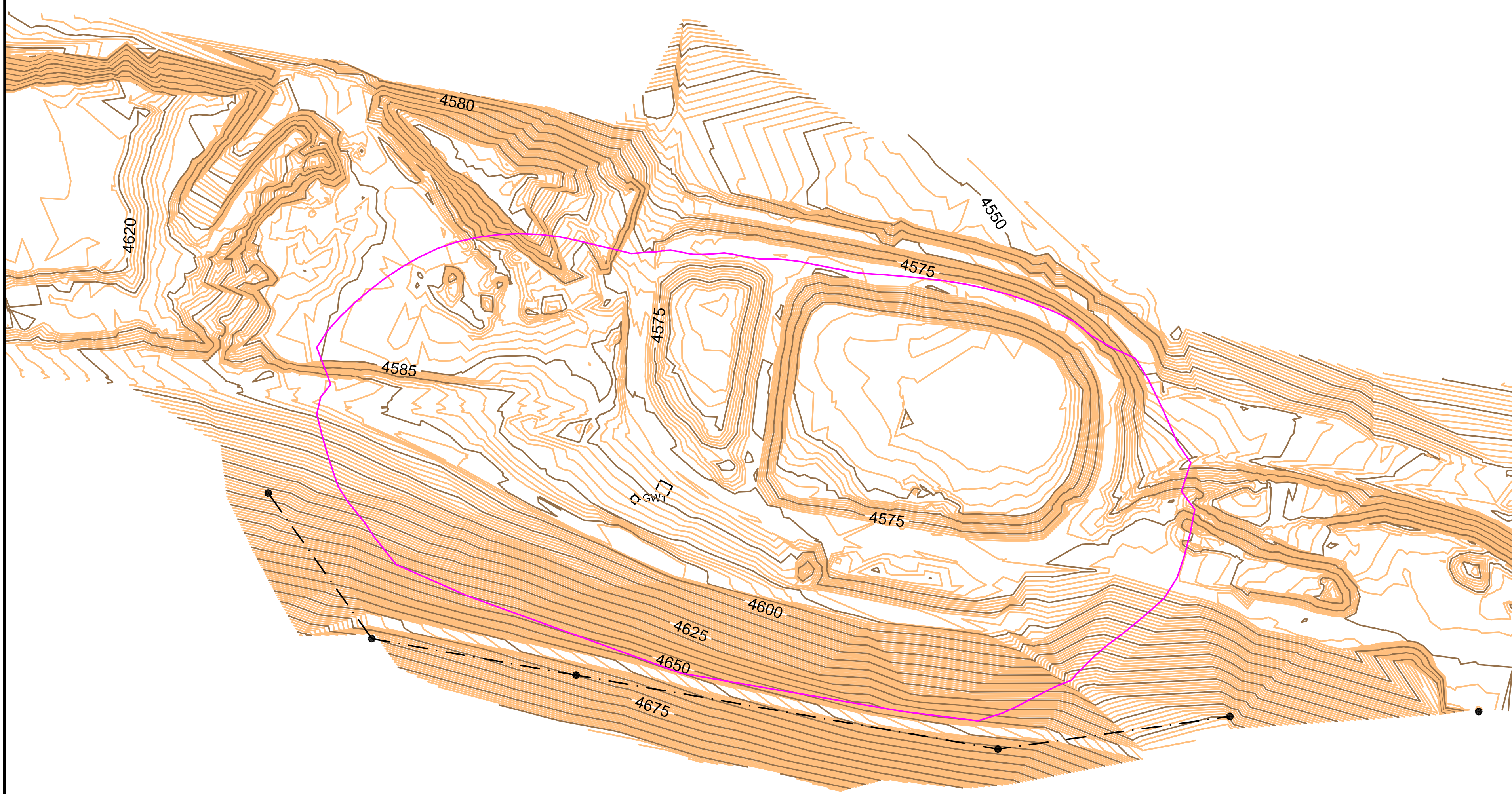
**TABLE 3-18 TAILINGS SAMPLE RESULTS FOR THE SILVER FOX MINOR SUBDIVISION TAILINGS IMPOUNDMENT**

| Analyte | Concentration (mg/Kg) |
|---|---|
| Antimony | <1 |
| Arsenic | <2 |
| Barium | 90 |
| Cobalt | <1 |
| Cadmium | <0.5 |
| Chromium | 3.0 |
| Copper | 8.0 |
| Iron | 11280 |
| Mercury | <0.1 |
| Manganese | 600 |
| Lead | <1 |
| Nickel | 4 |
| Zinc | 23 |

Site characterization results indicate that the mill tailings probably represent the most significant source of contaminants for impacting human health and the environment. The total estimated volume of mill tailings associated with Phases I and II of the Silver Creek Drainage Project is 612,000 cubic yards. The mill tailings and potential borrow sources for repository cover soils are located in an area that is nearly four miles long. Given these data and logistics, a potential repository site at the Goldsil tailings area was selected for evaluation based on the following criteria:

- an area which could accommodate the estimated mill tailings volume;
- an area which would have a reasonable chance of getting land ownership approval;
- an area which would provide for an acceptable buffer zone with Silver Creek and its floodplain;
- an area which would be somewhat central to all of the mill tailings areas;
- an area which has existing potential secondary roads that could serve as haulage route(s);
- an area which is reasonably close to the largest mill tailings volume;
- an area which is a reasonable distance from potential borrow source soil cap materials; and
- an area which would require a limited amount of waste excavation to prepare a portion of the repository pad to initiate waste loading operations.

Based on the above criteria, a potential repository site was selected in the area of the lined tailings impoundment located within the Goldsil tailings area. The property is exclusively owned by the St. Louis Drumlummon Mines, Inc. Figure 3-20 shows the potential repository site area, existing topography and preliminary design. The design indicates that the repository would




## EXISTING TOPOGRAPHY

LEGEND

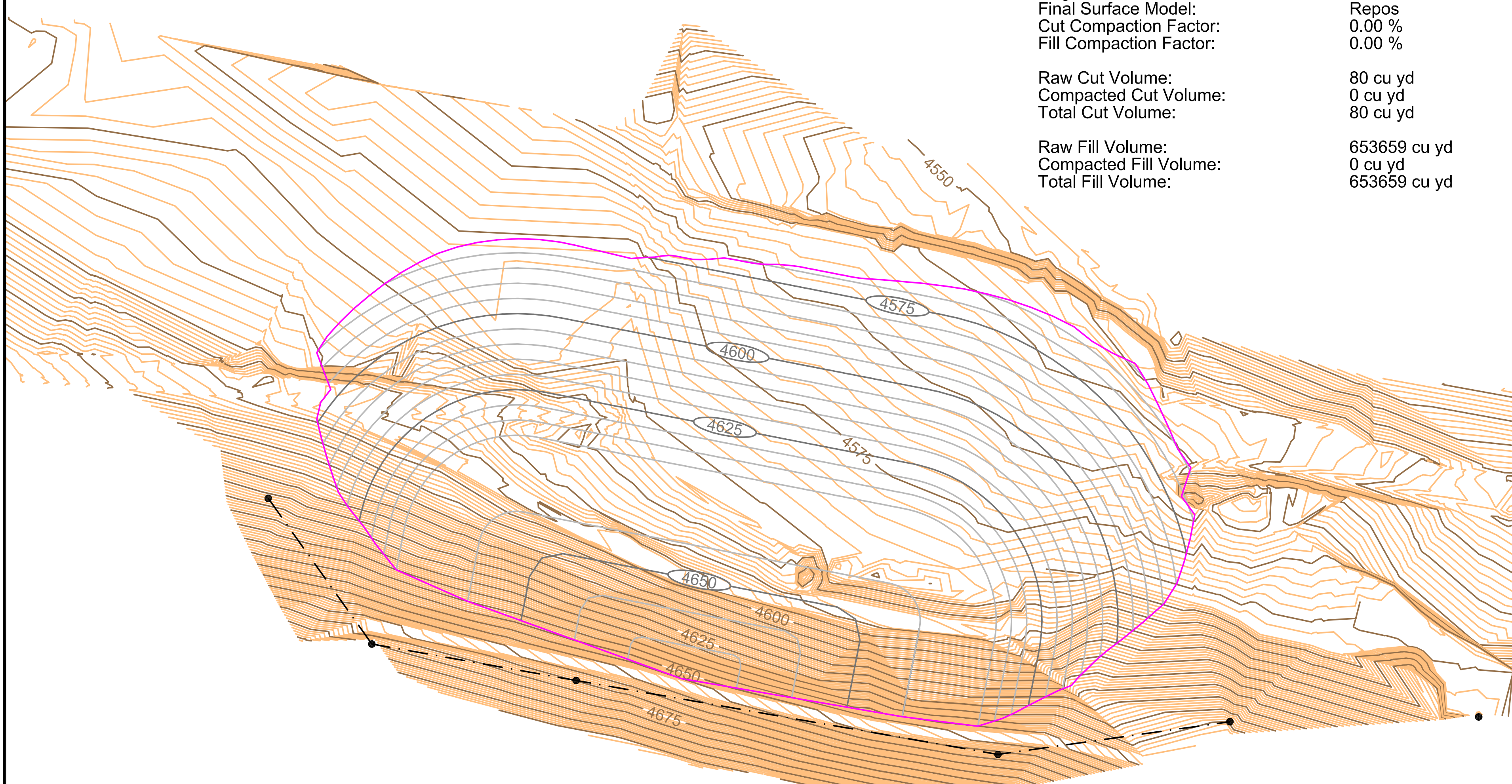
- 4600 EXISTING TOPOGRAPHY INDEX CONTOURS
- EXISTING TOPOGRAPHY INTERMEDIATE CONTOURS
- POTENTIAL REPOSITORY FOOTPRINT

0 100 200 300 400
SCALE IN FEET

N

Prismoidal Volume Results

| | |
|---|---|
| Original Surface Model: | NatGraded |
| Final Surface Model: | Repos |
| Cut Compaction Factor: | 0.00 % |
| Fill Compaction Factor: | 0.00 % |
| Raw Cut Volume: | 80 cu yd |
| Compacted Cut Volume: | 0 cu yd |
| Total Cut Volume: | 80 cu yd |
| Raw Fill Volume: | 653659 cu yd |
| Compacted Fill Volume: | 0 cu yd |
| Total Fill Volume: | 653659 cu yd |




## PRELIMINARY REPOSITORY DESIGN AND GRADED REPOSITORY BASE

LEGEND

- 4650 REPOSITORY INDEX CONTOUR
- REPOSITORY INTERMEDIATE CONTOUR
- POTENTIAL REPOSITORY FOOTPRINT
- 4600 GRADED REPOSITORY BASE INDEX CONTOURS
- GRADED REPOSITORY BASE INTERMEDIATE CONTOURS

0 100 200 300 400
SCALE IN FEET

N

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LEWIS & CLARK COUNTY, MONTANA

GOLDSIL TAILINGS AREA
POTENTIAL REPOSITORY SITE

FIGURE 3-20

| DESIGN: | DRAWN: KSR | CHECKED: CRS | APPROVED: | DATE: 4/2003 | JOB NO: A1348 | SCALE: AS SHOWN | FILENAME: A1348GTRepos.dwg |
|---|---|---|---|---|---|---|---|

occupy 12.6 acres, have a maximum thickness of 70 feet, and could accommodate an estimated 654,000 cubic yards of waste. The subgrade would consist of colluvium and/or alluvium down to limestone bedrock. The depth to bedrock is estimated at 44 feet or less below the surface based on previous wells completed in bedrock by Lindsey Drilling in 1974 for Silver Creek Mining. Static water levels (December 4, 2002) in groundwater monitoring wells completed by Olympus in the potential repository area indicate that the water table in the alluvial aquifer would be 14.4 to 25.7 feet below the existing topographic surface. Groundwater flow is at a relatively steep gradient and flow direction essentially parallels Silver Creek in this area.

### 3.11.2 Lower Pond Area Repository

A potential repository site is located directly south of the Lower Pond Area (Figure 3-8). The area has been previously excavated and was most likely the borrow source for the Lower Pond dam. Olympus completed a topographic survey of the potential repository area as shown on Figure 3-21 so that the volume could be estimated. A conceptual repository design was prepared to evaluate the potential volume of the repository. The conceptual repository design was based on a 5 percent repository crown slope to provide for positive drainage while allowing for settlement, and 4:1 side slopes. Based on the conceptual design shown on Figure 3-21, the potential repository area could accommodate in excess of 49,500 cubic yards of mine/mill waste. This would be enough to encapsulate the estimated volume of mill tailings from the Upper, Lower and Middle Ponds. In addition, the repository could be extended farther to the northwest into the Lower and Middle Pond areas to provide additional storage capacity.

No test pits were excavated into the potential repository area because the purpose of this project phase was reconnaissance. Similarly, no monitoring wells were installed in the repository area to evaluate groundwater conditions. Additional characterization will be required to evaluate the suitability of this repository site if it is selected for consideration.

### 3.11.3 Drumlummon Mine Open Pit Area Repository

A third repository option was evaluated in the open pit areas at the Drumlummon Mine. Figure 3-13 shows the location of the open pit areas. The purpose of a repository in this location would be two-fold: 1) to provide storage capacity for mine/mill wastes, and 2) to mitigate the highwalls associated with the open pits. Figure 3-22 shows the existing topography of the open pits and associated highwalls. There are a total of four open pit areas, labeled Pit #1, Pit #2, Pit #3 and Pit #4 (Figure 3-22). The maximum height of the highwalls associated with each of the open pits are summarized in Table 3-19. The maximum highwall height is approximately 100 feet in Pit #3.

Figure 3-23 shows the preliminary design of the repository surface. The repository would be designed to completely fill each pit area, thereby mitigating the exposed highwall. Figure 3-24 shows waste depth contours and estimated volume for the each open pit. The pit volumes are summarized in Table 3-19. The combined volume of the four open pits is approximately 106,190 cubic yards. This repository would contain approximately 17 percent of the tailings and 90 percent of the waste rock that have been identified during Phases I and II of the Silver Creek Drainage Project.

## Prismoidal Volume Results

| | |
|---|---|
| Original Surface Model: | Existing |
| Final Surface Model: | Repos |
| Cut Compaction Factor: | 0.00 % |
| Fill Compaction Factor: | 0.00 % |
| Raw Cut Volume: | 0 cu yd |
| Compacted Cut Volume: | 0 cu yd |
| Total Cut Volume: | 0 cu yd |
| Raw Fill Volume: | 49496 cu yd |
| Compacted Fill Volume: | 0 cu yd |
| Total Fill Volume: | 49496 cu yd |


LEGEND

4650 REPOSITORY INDEX CONTOUR
REPOSITORY INTERMEDIATE CONTOUR
4600 EXISTING TOPOGRAPHY INDEX CONTOURS
EXISTING TOPOGRAPHY INTERMEDIATE CONTOURS
PRELIMINARY REPOSITORY BOUNDARY

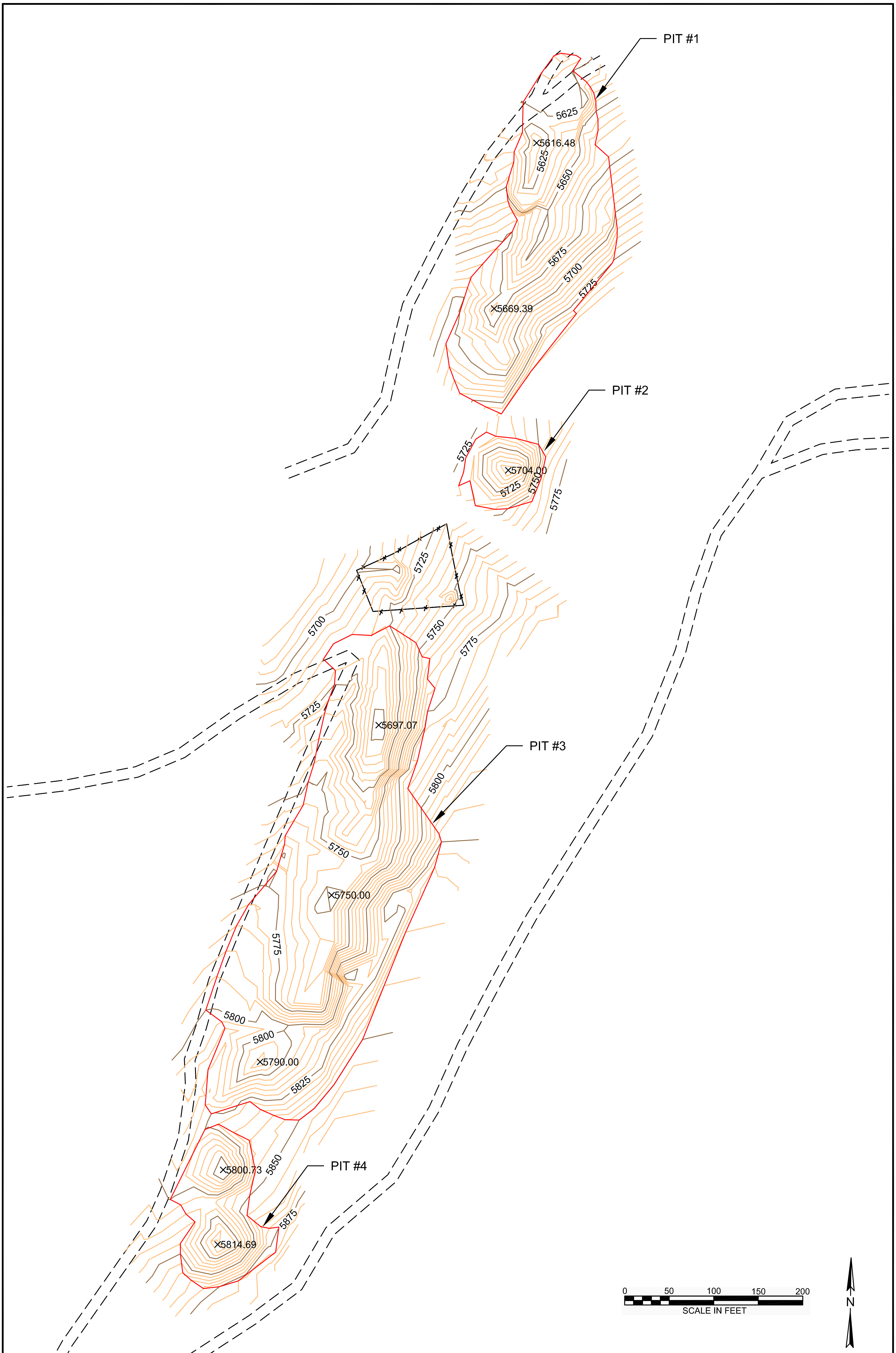
| NO. | REVISION DESCRIPTION | BY | DATE | DESIGN: | DRAWN: KSR | CHECKED: CRS |
|---|---|---|---|---|---|---|
| | | | | APPROVED: | DATE: 4/2003 | JOB NO: A1348 |
| | | | | SCALE: AS SHOWN | FILENAME: A1348LPRepos.dwg | |

MONTANA DEQ/MINE WASTE CLEANUP BUREAU
SILVER CREEK DRAINAGE PROJECT
LEWIS & CLARK COUNTY, MONTANA

**Olympus Technical Services, Inc.**

LOWER POND AREA
POTENTIAL REPOSITORY SITE

FIGURE
3-21

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SILVER CREEK DRAINAGE PROJECT
LEWIS & CLARK COUNTY, MONTANA

DRUMLUMMON MINE OPEN PIT AND HIGHWALL AREA EXISTING TOPOGRAPHY

FIGURE 3-22

| DESIGN: | DRAWN: KSR | CHECKED: CRS | APPROVED: | DATE: 4/2003 | JOB NO: A1348 | SCALE: AS SHOWN | FILENAME: A1348pits.dwg |
|---|---|---|---|---|---|---|---|

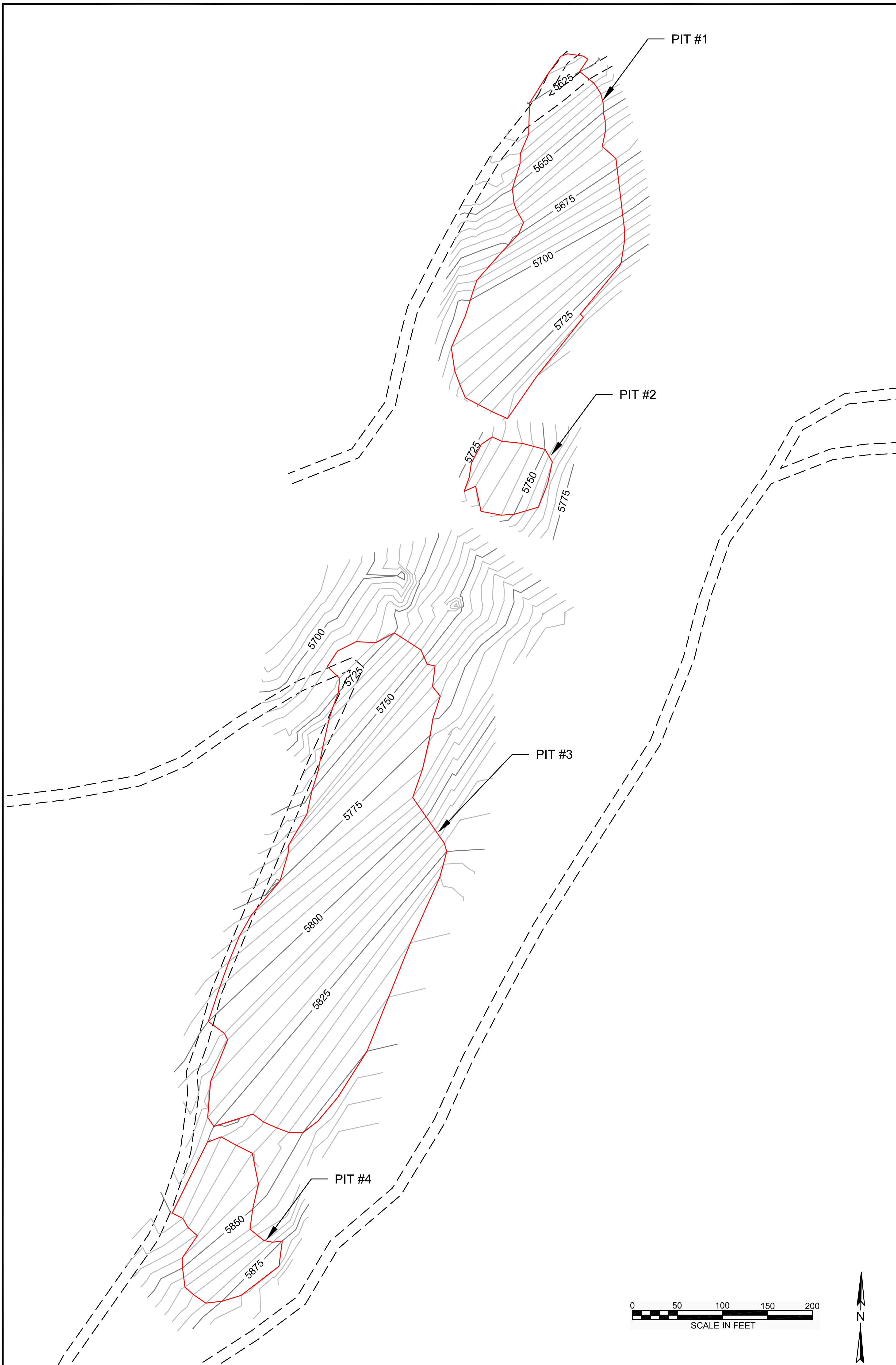
**TABLE 3-19 DRUMLUMMON MINE OPEN PIT AREA POTENTIAL REPOSITORY SITE VOLUME AND MAXIMUM HIGHWALL HEIGHTS**

| Pit No. | Estimated Volume (cubic yards) | Maximum Highwall Height (feet) |
|---|---|---|
| 1 | 23,030 | 80 |
| 2 | 2,980 | 56 |
| 3 | 71,880 | 100 |
| 4 | 8,300 | 65 |
| Total | 106,190 | |

Issues that would negatively affect the use of this repository site are access and topography. The existing access road to the open pit area is steep and narrow and would require significant improvements. A culvert or temporary bridge would be required where the existing road crosses Ottawa Gulch. The final slope of the repository surface would range from approximately 1.7:1 to 3.1:1, with an average slope of approximately 2.3:1. Slopes this steep would probably be more conducive to storage of waste rock rather than tailings because of slope stability concerns.

Another issue that would need to be addressed is safety while the pit is being backfilled. The two primary issues that would need to be addressed are the stability of the highwall and the stability of the pit floor. Spalling of the highwall during repository construction would constitute a serious safety hazard for workers. Similarly, the extent of workings below the pit floor are not known. Shallow workings below the pit floor could result in cave-ins, which would pose a serious safety hazard for workers. Geophysical investigations, such as ground penetrating radar, should be completed to evaluate the subsurface conditions prior to design and construction of the repository.

Additionally, there are adit openings within the open pits. Bat habitat investigations would likely be required to determine if the open pit area repository would have significant adverse impacts on bat habitat.

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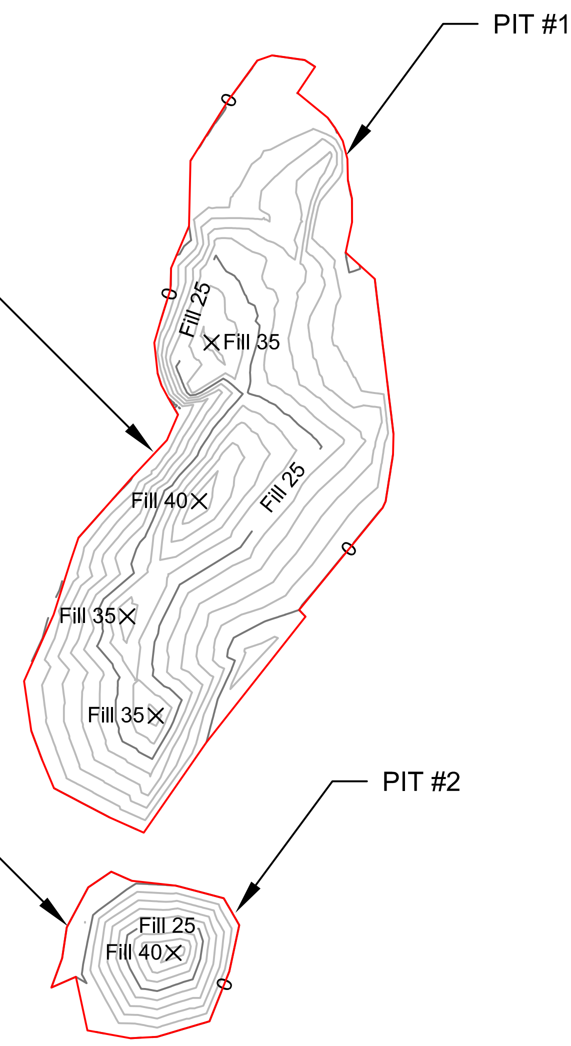
SILVER CREEK DRAINAGE PROJECT
LEWIS & CLARK COUNTY, MONTANA

DRUMLUMMON MINE OPEN PIT
WASTE ROCK REPOSITORY
SITE GRADING PLAN

FIGURE
3-23

| DESIGN: | DRAWN: KSR | CHECKED: CRS | APPROVED: | DATE: 4/2003 | JOB NO: A1348 | SCALE: AS SHOWN | FILENAME: A1348pits.dwg |
|---|---|---|---|---|---|---|---|

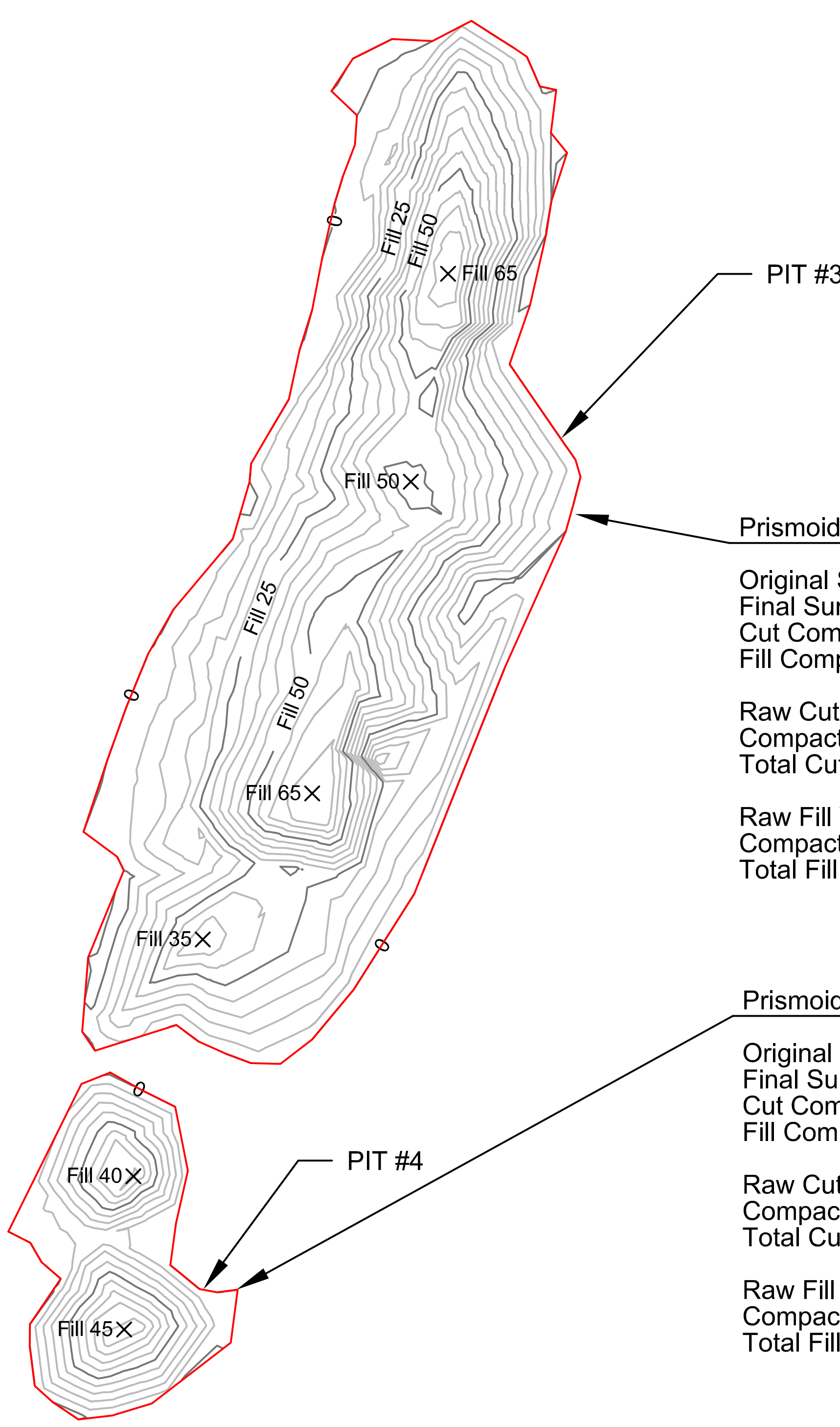



### Prismoidal Volume Results

| | |
|---|---|
| Original Surface Model: | Pit1 |
| Final Surface Model: | Pit1top |
| Cut Compaction Factor: | 0.00 % |
| Fill Compaction Factor: | 0.00 % |
| Raw Cut Volume: | 112 cu yd |
| Compacted Cut Volume: | 0 cu yd |
| Total Cut Volume: | 112 cu yd |
| Raw Fill Volume: | 23028 cu yd |
| Compacted Fill Volume: | 0 cu yd |
| Total Fill Volume: | 23028 cu yd |

### Prismoidal Volume Results

| | |
|---|---|
| Original Surface Model: | Pit2 |
| Final Surface Model: | Pit2Top |
| Cut Compaction Factor: | 0.00 % |
| Fill Compaction Factor: | 0.00 % |
| Raw Cut Volume: | 46 cu yd |
| Compacted Cut Volume: | 0 cu yd |
| Total Cut Volume: | 46 cu yd |
| Raw Fill Volume: | 2984 cu yd |
| Compacted Fill Volume: | 0 cu yd |
| Total Fill Volume: | 2984 cu yd |




### Prismoidal Volume Results

| | |
|---|---|
| Original Surface Model: | Pit3&4 |
| Final Surface Model: | Pit3top |
| Cut Compaction Factor: | 0.00 % |
| Fill Compaction Factor: | 0.00 % |
| Raw Cut Volume: | 64 cu yd |
| Compacted Cut Volume: | 0 cu yd |
| Total Cut Volume: | 64 cu yd |
| Raw Fill Volume: | 71880 cu yd |
| Compacted Fill Volume: | 0 cu yd |
| Total Fill Volume: | 71880 cu yd |

### Prismoidal Volume Results

| | |
|---|---|
| Original Surface Model: | Pit3&4 |
| Final Surface Model: | Pit4top |
| Cut Compaction Factor: | 0.00 % |
| Fill Compaction Factor: | 0.00 % |
| Raw Cut Volume: | 1 cu yd |
| Compacted Cut Volume: | 0 cu yd |
| Total Cut Volume: | 1 cu yd |
| Raw Fill Volume: | 8301 cu yd |
| Compacted Fill Volume: | 0 cu yd |
| Total Fill Volume: | 8301 cu yd |

0 50 100 150 200
SCALE IN FEET

N

**Olympus Technical Services, Inc.**

MONTANA DEQ/MINE WASTE CLEANUP BUREAU
SILVER CREEK DRAINAGE PROJECT
LEWIS & CLARK COUNTY, MONTANA

DRUMLUMMON MINE OPEN PIT
AREA POTENTIAL REPOSITORY
SITE WASTE DEPTH CONTOURS

FIGURE
3-24

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| DESIGN: | DRAWN: KSR | CHECKED: CRS | APPROVED: | DATE: 4/2003 | JOB NO: A1348 | SCALE: AS SHOWN | FILENAME: A1348pits.dwg |

# 4.0 SUMMARY OF THE APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

The summary of the applicable or relevant and appropriate requirements (ARARs) was compiled from a draft document describing ARARs for abandoned mine sites produced by the Montana Department of Environmental Quality - Mine Waste Cleanup Bureau (DEQ-MWCB). These ARARs, along with those prepared by ARCO for the Streamside Tailings Operable Unit (ARCO, 1995) and the Montana Department of Environmental Quality-Hazardous Waste Site Cleanup Bureau for mine sites, were reviewed by Olympus to develop a listing of potential federal and state ARARs for the Silver Creek Drainage Project. The federal and state ARARs are summarized in Table 4-1 and Table 4-2, respectively. Appendix A provides detailed descriptions of potential federal and state ARARs. The description of the federal and state ARARs includes summaries of legal requirements that, in many cases, attempt to set out the requirement in a simple fashion useful in evaluating compliance with the requirement. In the event of any inconsistency between the law itself and the summaries in this section, the ARAR is ultimately the requirement as set out in the law, rather than any paraphrase provided here.

## TABLE 4-1 SUMMARY OF PRELIMINARY FEDERAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS.

| Standard, Requirement Criteria Or Limitation | Citation | Description | ARAR Status |
|---|---|---|---|
| **FEDERAL CONTAMINANT-SPECIFIC** | | | |
| Safe Drinking Water Act | 42 USC §§ 300f | | |
| National Primary Drinking Water Standards | 40 CFR Part 141 | Establishes health-based standards (MCLs) for public water systems. | Relevant and Appropriate |
| National Secondary Drinking Water Standards | 40 CFR Part 143 | Establishes welfare-based standards (secondary MCLs) for public water systems. | Relevant and Appropriate |
| Clean Water Act | 33 USC. § 1251-1375 | | |
| Water Quality Standards | 40 CFR Part 131 | Sets criteria for water quality based on toxicity to aquatic organisms and human health. | Applicable |
| National Pollutant Discharge Elimination System (NPDES) | 40 CFR Part 122 | General permits for discharge from construction. | Applicable |
| Clean Air Act | 42 USC § 7409 | | |
| National Primary and Secondary Ambient Air Quality Standards | 40 CFR Part 50 | Air quality levels that protect public health. | Applicable |
| Resource Conservation and Recovery Act | 42 USC § 6901 | | |
| Lists Of Hazardous Waste | 40 CFR Part 261, Subpart D | Defines those solid wastes that are subject to regulation as hazardous wastes under 40 CFR Parts 262-265 and Parts 124, 270 and 271. | Applicable |

## TABLE 4-1 SUMMARY OF PRELIMINARY FEDERAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (CONTINUED)

| Standard, Requirement Criteria Or Limitation | Citation | Description | ARAR Status |
|---|---|---|---|
| **FEDERAL LOCATION-SPECIFIC** | | | |
| National Historic Preservation Act | 16 USC § 470;<br>36 CFR Part 800;<br>40 CFR §6.301(b) | Requires Federal Agencies to take into account the effect of any Federally-assisted undertaking or licensing on any district, site, building, structure, or object that is included in or eligible for inclusion in the National Register of Historic Places and to minimize harm to any National Historic Landmark adversely or directly affected by an undertaking. | Applicable |
| Archaeological and Historic Preservation Act | 16 USC § 469;<br>40 CFR § 6.301(c) | Establishes procedures to provide for preservation of historical and archaeological data which might be destroyed through alteration of terrain as a result of a Federal construction project or a Federally licensed activity or program. | Applicable |
| Protection of Wetlands Order | 40 CFR Part 6, Appendix A, Executive Order No. 11,990 | Avoid adverse impacts associated with destruction or loss of wetlands and avoid support of new construction in wetlands if a practicable alternative exists. | Applicable |
| Historic Sites, Buildings and Antiquities Act | 16 USC §§ 461-467;<br>40 CFR § 6.301(a) | Requires Federal agencies to consider the existence and location of landmarks on the National Registry of Natural Landmarks to avoid undesirable impacts on such landmarks. | Applicable |
| Fish and Wildlife Coordination Act | 16 USC §§ 661 et seq.;<br>40 CFR § 6.302(g) | Requires consultation when Federal department or agency proposes or authorizes any modification of any stream or other water body and adequate provision for protection of fish and wildlife resources. | Applicable |
| Floodplain Management Order | 40 CFR Part 6<br>Executive Order No. 11,988 | Requires Federal agencies to evaluate the potential effects of actions they may take in a floodplain to avoid the adverse impacts associated with direct development of a floodplain. | Applicable |

## TABLE 4-1 SUMMARY OF PRELIMINARY FEDERAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (CONTINUED)

| Standard, Requirement Criteria Or Limitation | Citation | Description | ARAR Status |
|---|---|---|---|
| Endangered Species Act | 16 USC §§ 1531-1543;<br>40 CFR § 6.302(h);<br>50 CFR Part 402 | Activities may not jeopardize the continued existence of any threatened or endangered species or destroy or adversely modify a critical habitat. | Applicable |
| Bald Eagle Protection Act | 16 USC §§ 668 | Requires consultation with the USFWS during reclamation design and construction to ensure that any cleanup of the site does not unnecessarily adversely affect the Bald Eagle or Golden Eagle. | Applicable |
| Migratory Bird Treaty Act | 16 USC §§ 703 | Establishes a federal responsibility for the protection of the international migratory bird resource and requires consultation with the USFWS during reclamation design and construction to ensure the cleanup of the site does not unnecessarily impact migratory birds. Specific mitigative measures may be identified for compliance with this requirement. | Applicable |
| **FEDERAL ACTION-SPECIFIC** | | | |
| Clean Water Act | 33 USC § 1342 | | |
| National Pollutant Discharge Elimination System (NPDES) | 40 CFR Part 122 | Requires permits for the discharge of pollutants from any point source into waters of the United States. | Relevant and Appropriate |
| Surface Mining Control and Reclamation Act | 30 USC §§ 1201-1328 | Protects the environment from effects of surface mining activities. | Relevant and Appropriate |
| | 30 CFR Part 784 | Governs underground mining permit applications and minimum requirements for reclamation and operations plans. | Relevant and Appropriate |

## TABLE 4-1 SUMMARY OF PRELIMINARY FEDERAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (CONTINUED)

| Standard, Requirement Criteria Or Limitation | Citation | Description | ARAR Status |
|---|---|---|---|
| Surface Mining Control and Reclamation Act (continued) | 30 CFR Part 816 | Outlines permanent program performance standards for surface mining activities. | Relevant and Appropriate |
| Hazardous Materials Transportation Regulations | 49 USC §§ 5101-5105 | | |
| Standards Applicable to Transporters of Hazardous Waste | 49 CFR Part 10 | Regulates transportation of hazardous waste. | Relevant and Appropriate |
| Resource Conservation and Recovery Act | | | |
| Land Disposal | 40 CFR Part 268 | Establishes a timetable for restriction of burial of wastes and other hazardous materials. | Applicable |
| Criteria for Classification of Solid Waste Disposal Facilities and Practices | 40 CFR Part 257 | Establishes criteria for use in determining which solid waste disposal facilities and practices pose a reasonable probability of adverse effects on health or the environment and thereby constitute prohibited open dumps. | Applicable |
| Standards for Transporters of Hazardous Waste | 40 CFR Part 263 | Establishes standards which apply to persons transporting hazardous waste within the U.S. if the transportation requires a manifest under 40 CFR Part 262. | Applicable |
| Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities | 40 CFR Part 264 | Establishes minimum national standards which define the acceptable management of hazardous waste for owners and operators of facilities which treat, store, or dispose of hazardous waste. | Applicable |

## TABLE 4-1 SUMMARY OF PRELIMINARY FEDERAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (CONTINUED)

| Standard, Requirement Criteria Or Limitation | Citation | Description | ARAR Status |
|---|---|---|---|
| Occupational Safety And Health Act | 29 USC § 655 | | |
| Hazardous Waste Operations and Emergency Response | 29 CFR 1910.120 | Defines standards for employee protection during initial site characterization and analysis, monitoring activities, materials handling activities, training & emergency response. | Applicable |

## TABLE 4-2 SUMMARY OF PRELIMINARY STATE APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

| Standard, Requirement Criteria Or Limitation | Citation | Description | ARAR Status |
|---|---|---|---|
| **STATE CONTAMINANT-SPECIFIC** | | | |
| Montana Water Quality Act | 75-101 et seq., MCA | Laws to prevent, abate, and control the pollution of state waters. | Applicable |
| Regulations Establishing Ambient Surface Water Quality Standards | ARM 17.30.606-630 | Provides the water use classification for various streams and imposes specific water quality standards per classification. | Applicable |
| Regulations Establishing Ambient Surface Water Quality Nondegradation Standards | ARM 17.30.705-717 | Applies nondegradation requirements to any activity which could cause a new or increased source of pollution to State waters and outlines review procedures. | Applicable |
| | ARM 17.30.1203 | Technology-based treatment for MPDES permits. | Applicable |
| Montana Groundwater Pollution Control System Regulations | ARM 17.30.1006 | Classifies groundwater into Classes I through IV based on the present and future most beneficial uses of the groundwater and establishes groundwater classification standards. | Applicable |
| Public Water Supplies Act | 75-6-101, MCA | Establishes public policy of MT to protect, maintain, and improve the quality and potability of water for public water supplies and domestic uses. | Relevant and Appropriate |
| Public Water Supply Regulations | ARM 17.30.204 | Establishes maximum contaminant levels (MCLs) for inorganic chemicals in community water systems. | Relevant and Appropriate |
| | ARM 17.30.205 | Establishes the maximum turbidity contaminant levels for public water supply systems which use surface water in whole or in part. | Relevant and Appropriate |

## TABLE 4-2 SUMMARY OF PRELIMINARY STATE APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (CONTINUED)

| Standard, Requirement Criteria Or Limitation | Citation | Description | ARAR Status |
|---|---|---|---|
| Clean Air Act Of Montana | 75-2-101 MCA | Montana's policy is to achieve and maintain such levels of air quality as will protect human health and safety and, to the greatest degree practicable, prevent injury to plant and animal life and property. | Relevant and Appropriate |
| Air Quality Regulations | ARM 17.8.222 | No person shall cause or contribute to concentrations of lead in the ambient air which exceed the following 90-day average: 1.5 micrograms per cubic meter of air. | Applicable |
| | ARM 17.8.220 | No person shall cause or contribute to concentrations of particulate matter in the ambient air such that the mass of settled particulate matter exceeds the following 30-day average: 10 grams per square meter. | Applicable |
| | ARM 17.8.223 | No person may cause or contribute to concentrations of PM-10 in the ambient air which exceed the following standard: 1) 24-hr. avg.: 150 micrograms per cubic meter of air, with no more than one expected exceedance per year; 2) Annual avg.: 50 micrograms per cubic meter of air. | Applicable |
| | ARM 17.8.308 | States “no person shall cause or authorize the production, handling, transportation or storage of any material unless reasonable precautions to control emissions of airborne particulate matter are taken.” | Applicable |
| | ARM 17.8.304 (2) | States no person shall cause opacity of 20% or greater averaged over 6 consecutive minutes. | Applicable |

## TABLE 4-2 SUMMARY OF PRELIMINARY STATE APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (CONTINUED)

| Standard, Requirement Criteria Or Limitation | Citation | Description | ARAR Status |
|---|---|---|---|
| Air Quality Regulations (continued) | ARM 17.8.341 | Sets forth emission standards for hazardous air pollutants. | Applicable |
| | ARM 17.24.761 | Requires a fugitive dust control program be implemented in reclamation operations. | Applicable |
| Occupational Health Act of Montana | 50-70-101, MCA | The purpose of this act is to achieve and maintain such conditions of the work place as will protect human health and safety. | Applicable |
| Occupational Air Contaminants Requirements | ARM 17.74.102 | Establishes maximum threshold limit values for air contaminants believed that nearly all workers may be repeatedly exposed day after day without adverse health effects. | Applicable |
| Occupational Noise Regulations | ARM 17.74.101 | Addresses occupational noise levels and provides that no worker shall be exposed to noise levels in excess of specified levels. | Applicable |
| **STATE LOCATION-SPECIFIC** | | | |
| Floodplain and Floodway Management Act | 76-5-401, MCA | Lists the uses permissible in a floodway and generally prohibits permanent structures, fill, or permanent storage of materials or equipment. | Applicable |
| | 76-5-402 MCA | Lists the permissible uses within the floodplain but outside of floodway. | Applicable |

**TABLE 4-2 SUMMARY OF PRELIMINARY STATE APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (CONTINUED)**

| Standard, Requirement Criteria Or Limitation | Citation | Description | ARAR Status |
|---|---|---|---|
| Floodplain and Floodway Management Act (continued) | 76-5-403, MCA | Lists certain uses which are prohibited in a designated floodway, including any change that will cause water to be diverted from the established floodway, cause erosion, obstruct the natural flow of water, or reduce the carrying capacity of the floodway, or the concentration or permanent storage of an object subject to flotation or movement during flood level periods. | Applicable |
| Floodplain Management Regulations | ARM 36.15.602 | Uses allowed in the floodway which require a permit. | Applicable |
| | ARM 36.15.601 | Open space uses allowed in the floodway without a permit. | Applicable |
| | ARM 36.15.216 | The factors to consider in determining whether a permit should be issued to establish or alter an artificial obstruction or nonconforming use in the floodplain or floodway are set forth in this section. | Applicable |
| | ARM 36.15.603 | Proposed diversions or changes in place of diversions must be evaluated by DNRC to determine whether they may significantly affect flood velocities. | Applicable |
| | ARM 36.15.604 | Prohibits new artificial obstructions or nonconforming uses that will significantly increase the upstream elevation of the base flood 0.5 feet or significantly increase flood velocities. | Applicable |

## TABLE 4-2 SUMMARY OF PRELIMINARY STATE APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (CONTINUED)

| Standard, Requirement Criteria Or Limitation | Citation | Description | ARAR Status |
|---|---|---|---|
| Floodplain Management Regulations (continued) | ARM 36.15.605 | Identifies artificial obstructions and nonconforming uses that are prohibited within the designated floodway except as allowed by permit and includes a structure or excavation that will cause water to be diverted from the established floodway, cause erosion, obstruct the natural flow of water, or reduce the carrying capacity of the floodway. Solid waste disposal and storage of highly toxic, flammable, or explosive materials are also prohibited. | Applicable |
| | ARM 36.15.606 | Identifies flood control works that are allowed with designated floodways pursuant to permit and certain conditions including: flood control levies and flood walls, riprap, channelization projects, and dams. | Applicable |
| | ARM 36.15.701 | Describes allowed uses in the flood fringe. | Applicable |
| | ARM 36.15.703 | Prohibited uses within the flood fringe including solid and hazardous waste disposal and storage of toxic, flammable, or explosive materials. | Applicable |
| | ARM 36.15.801 | Allowed uses where the floodway is not designated or where no flood elevations are available. | Applicable |

## TABLE 4-2 SUMMARY OF PRELIMINARY STATE APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (CONTINUED)

| Standard, Requirement Criteria Or Limitation | Citation | Description | ARAR Status |
|---|---|---|---|
| Natural Streambed and Land Preservation Standards | 87-5-501-504, MCA | Fish and wildlife resources are to be protected and no construction project or hydraulic project shall adversely affect game or fish habitat. | Applicable |
| | ARM 36.2.410 | Defines project information which applicant must provide to district and provides that stream projects must be designed and constructed to minimize adverse impacts to stream, future disturbances to the stream, and erosion; temporary structures used during construction must handle reasonably anticipated high flows; channel alteration must be designed to retain original stream length or otherwise provide for hydrologic stability; streambank vegetation must be protected except where removal is necessary and riprap, rock, or other material must be sized adequately to protect streambank erosion. | Applicable |
| Antiquities Act | 22-3-424, MCA | Heritage and paleontological sites are given appropriate consideration. | Relevant and Appropriate |
| | 22-3-433, MCA | Evaluation of environmental impacts include consultation with State Historic Preservation Officer (SHPO). | Relevant and Appropriate |
| | 22-3-435, MCA | A heritage or paleontological site is to be reported to the SHPO. | Relevant and Appropriate |
| Cultural Resource Regulations | ARM 12.8.503-508 | Procedures to ensure adequate consideration of cultural values. | Relevant and Appropriate |

## TABLE 4-2 SUMMARY OF PRELIMINARY STATE APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (CONTINUED)

| Standard, Requirement Criteria Or Limitation | Citation | Description | ARAR Status |
|---|---|---|---|
| **STATE ACTION SPECIFIC** | | | |
| Montana Water Quality Act | 75-5-605, MCA | Pursuant to this section, it is unlawful to cause pollution of any state waters, to place any wastes in a location where they are likely to cause pollution of any state waters, to violate any permit provision, to violate any provision of the Montana Water Quality Act, to construct, modify, or operate a system for disposing of waste (including sediment, solid waste and other substances that may pollute state waters) which discharge into any state waters without a permit or discharge waste into any state waters. | Applicable |
| Montana Surface Water Quality Regulations | ARM 17.30.635 | Industrial waste must receive treatment equivalent to the best practicable available control technology. | Applicable |
| | ARM 17.30.607-629 | Provides for classification of state waters. | Applicable |
| | ARM 17.30.637 | Requires that the State's surface waters be free from, among other things, substances that will create concentrations or combinations of materials that are harmful to human, animal, plant, or aquatic life. Moreover, no waste may be discharged and no activities may be conducted that can reasonably be expected to violate any of the standards. | Applicable |

## TABLE 4-2 SUMMARY OF PRELIMINARY STATE APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (CONTINUED)

| Standard, Requirement Criteria Or Limitation | Citation | Description | ARAR Status |
|---|---|---|---|
| Nondegradation of Water Quality | ARM 17.30.705-717 | Applies nondegradation requirements to any activity which would cause a new or increased source of pollution to state waters and outlines review procedures. | Applicable |
| Montana Groundwater Act | | | |
| Montana Groundwater Pollution Control System Regulations | ARM 17.30.1011 | Requires that any groundwater whose existing quality is higher than the standard for its classification must be maintained at that high quality in accordance with 75-5-303, MCA, and ARM 17.30.701 et. seq. | Applicable |
| | ARM 17.30.1006 | Classifies groundwater into Classes I through IV based on the present and future most beneficial uses of the groundwater and establishes groundwater classification standards. | Applicable |
| Clean Air Act Of Montana | 75-2-101 MCA | Montana's policy is to achieve and maintain such levels of air quality as will protect human health and safety and, to the greatest degree practicable, prevent injury to plant and animal life and property. | Applicable |
| Air Quality Requirements | ARM 17.8.222 | No person shall cause or contribute to concentrations of lead in the ambient air which exceed the following 90-day average: 1.5 micrograms per cubic meter of air. | Applicable |
| | ARM 17.8.604 | Lists certain wastes that may not be disposed of by open burning. | Applicable |

## TABLE 4-2 SUMMARY OF PRELIMINARY STATE APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (CONTINUED)

| Standard, Requirement Criteria Or Limitation | Citation | Description | ARAR Status |
|---|---|---|---|
| Air Quality Requirements (continued) | ARM 17.8.308-310 | No person shall cause or authorize the production, handling, transportation or storage of any material unless reasonable precautions to control emissions of airborne particulate matter are taken. | Applicable |
| Montana Solid Waste Management Act | 75-10-201, MCA | Public policy is to control solid waste management systems to protect the public health and safety and to conserve natural resources whenever possible. | Applicable |
| Solid Waste Management Regulations | ARM 17.50.505 | The standards for solid waste disposal are set forth in this provision. | Applicable |
| | ARM 17.50.510 | General operational and maintenance requirements for solid waste management facilities. | Applicable |
| | ARM 17.50.523 | Solid waste must be transported In such a manner as to prevent its discharge, dumping, spilling or leaking from the transport vehicle. | Applicable |
| Montana Hazardous Waste Act and Underground Storage Tank Act | 5-10-402, MCA | It's the policy of the State to "protect the public health and safety, the health of living organisms, and the environment from the effects of the improper, inadequate, or unsound management of hazardous wastes". | Applicable |

## TABLE 4-2 SUMMARY OF PRELIMINARY STATE APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (CONTINUED)

| Standard, Requirement Criteria Or Limitation | Citation | Description | ARAR Status |
|---|---|---|---|
| Montana Hazardous Waste Regulations | ARM 17.54.701,702 and 705 | By reference to federal regulatory requirements, these sections establish standards for all permitted hazardous waste management facilities.<br>1) 40 CFR 264.11 (referenced by ARM 17.54.702) establishes that hazardous waste management facilities must be closed in such a manner as to minimize the need for further maintenance and to control, minimize or eliminate, to the extent necessary to protect public health and the environment, post-closure escape of hazardous wastes, hazardous constituents, leachate, contaminated runoff or hazardous waste decomposition products to the ground or surface waters or the atmosphere.<br><br>2) 40 CFR 264.228(a) (incorporated by reference by ARM 17.54.702) requires that at closure, free liquids must be removed or solidified, the wastes stabilized and the waste management unit covered.<br><br>3) 40 CFR 264.228 and 310 (incorporated by reference by ARM 17.54.702) requires that surface impoundments and landfill caps must: (a) provide long-term minimization of migration of liquids through the unit; (b) function with minimum maintenance; (c) promote drainage and minimize erosion or abrasion of the final cover; d) accommodate settling and subsidence; and (e) have a permeability less than or equal to the permeability of the natural subsoil present. | Relevant and Appropriate |

## TABLE 4-2 SUMMARY OF PRELIMINARY STATE APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (CONTINUED)

| Standard, Requirement Criteria Or Limitation | Citation | Description | ARAR Status |
|---|---|---|---|
| Montana Hazardous Waste Regulations (continued) | ARM 17.54.701,-702 and 705 | 4) 40 CFR 264.119 (incorporated by reference in ARM 17.54.702) requires that a map be provided showing the dimensions of waste disposal units, together with the types and amounts of waste disposed of in each unit. Additionally, the owner must record a deed restriction, in accordance with state law, that will in perpetuity notify potential purchasers that the property has been used for waste disposal and that its use is restricted. | Relevant and Appropriate |
| | ARM 17.54.111-113 | Establishes permit conditions, duration of permits, schedules of compliance, and requirements for recording and reporting. | Relevant and Appropriate |
| <u>Montana Strip and Underground Mine Reclamation Act</u> | 82-4-231, MCA | Sets forth objectives that require the operator to prepare a plan and to reclaim and revegetate the land affected by his operation. | Relevant and Appropriate |
| | 82-4-233, MCA | Requires that after the operation has been backfilled, graded, topsoiled and approved, the operator shall establish a vegetative cover on all impacted lands. Specifications for the vegetative cover and performance are provided. | Relevant and Appropriate |
| Backfilling and Grading Requirements | ARM 17.24.501 | Gives general backfilling and grading requirements. | Relevant and Appropriate |
| | ARM 17.24.519 | The operator may be required to monitor settling of regraded areas. | Relevant and Appropriate |

## TABLE 4-2 SUMMARY OF PRELIMINARY STATE APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (CONTINUED)

| Standard, Requirement Criteria Or Limitation | Citation | Description | ARAR Status |
|---|---|---|---|
| Hydrology Requirements | ARM 17.24.631 | Reclamation operations must be planned and conducted to minimize disturbance and to prevent material damage to the prevailing hydrologic balance. | Relevant and Appropriate |
| | ARM 17.24.633 | Specifies that sediment controls must be maintained until the disturbed area has been restored and revegetated. | Relevant and Appropriate |
| | ARM 17.24.634 | Drainage design shall emphasize pre-mining channel and floodplain configurations that blend with the undisturbed drainage system above and below; and will meander naturally; remain in dynamic equilibrium with the system; improve unstable pre-mining conditions; provide for floods; provide for long term stability of landscape; and establish a pre-mining diversity of aquatic habitats and riparian vegetation. | Relevant and Appropriate |
| | ARM 17.24.635-637 | Sets forth requirements for temporary and permanent diversions. | Relevant and Appropriate |
| | ARM 17.24.638 | Sediment control measures shall be designed using the best technology currently available to prevent additional sediment to streamflows, meet the more stringent of federal or state effluent limitation, and minimize erosion. | Relevant and Appropriate |

## TABLE 4-2 SUMMARY OF PRELIMINARY STATE APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (CONTINUED)

| Standard, Requirement Criteria Or Limitation | Citation | Description | ARAR Status |
|---|---|---|---|
| Hydrology Requirements (continued) | ARM 17.24.640 | Provides that discharge from sedimentation ponds, impoundments, and diversions shall be controlled by vegetation, energy dissipaters, riprap channels, and other measures, where necessary, to reduce erosion, prevent deepening or enlargement of stream channels, and to minimize disturbance of the hydrologic balance. | Relevant and Appropriate |
| | ARM 17.24.641 | Sets methods for preventing drainage from acid-and toxic-forming spoils into ground and surface waters. | Relevant and Appropriate |
| | ARM 17.24.642 | Prohibits permanent impoundments with certain exceptions, and sets standards for temporary and permanent impoundments. | Relevant and Appropriate |
| | ARM 17.24.643-646 | Provides for groundwater and groundwater recharge protection, and surface and groundwater monitoring. | Relevant and Appropriate |
| | ARM 17.24.649 | Prohibits the discharge, diversion, or infiltration of surface and groundwater into existing underground mine workings. | Relevant and Appropriate |
| Top Soiling, Revegetation, and Protection of Wildlife and Air Resource Regulations | ARM 17.24.701-702 | Requirements for stockpiling soil. | Relevant and Appropriate |
| | ARM 17.24.703 | Materials other than, or along with, soil for final surfacing of spoils or other disturbances must be capable of supporting the approved vegetation and post-mining land use. | Relevant and Appropriate |

## TABLE 4-2 SUMMARY OF PRELIMINARY STATE APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (CONTINUED)

| Standard, Requirement Criteria Or Limitation | Citation | Description | ARAR Status |
|---|---|---|---|
| Top Soiling, Revegetation, and Protection of Wildlife and Air Resource Regulations (continued) | ARM 17.24.711 | Requires a diverse, effective, and permanent vegetative cover of the same seasonal variety native to the area affected and capable of meeting the criteria set forth in 82-4-233, MCA shall be established on all areas of land affected except water areas and surface areas of roads. | Relevant and Appropriate |
| | ARM 17.24.713 | Specifies that seeding and planting of disturbed areas must be conducted during the first appropriate period for favorable planting after final seedbed preparation; but not longer than 90 days after top soil placement. | Relevant and Appropriate |
| | ARM 17.24.714 | According to this section, as soon as practical, a mulch or cover crop must be used on all regraded and resoiled areas to control erosion, to promote germination of seeds, and to increase moisture retention of soil until permanent cover is established. | Relevant and Appropriate |
| | ARM 17.24.716 | Establishes the required method of revegetation and provides that introduced species may be substituted for native species as part of an approved plan. | Relevant and Appropriate |
| | ARM 17.24. 717 | Whenever tree species are necessary, trees adapted for local site conditions and climate shall be used. | Relevant and Appropriate |
| | ARM 17.24.718 | Soil amendments must be used as necessary to aid in the establishment of permanent vegetation; irrigation, management, fencing, or other measures may also be used after review and approval by the department. | Relevant and Appropriate |

## TABLE 4-2 SUMMARY OF PRELIMINARY STATE APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (CONTINUED)

| Standard, Requirement Criteria Or Limitation | Citation | Description | ARAR Status |
|---|---|---|---|
| Top Soiling, Revegetation, and Protection of Wildlife and Air Resource Regulations (continued) | ARM 17.24.719 | Livestock grazing on reclaimed land is prohibited until revegetation is established and can sustain managed grazing. | Relevant and Appropriate |
| | ARM 17.24.721 | Section specifies that rills and gullies greater than 9 inches which form on the reclaimed area must be filled, graded or otherwise stabilized and the area reseeded or replanted. | Relevant and Appropriate |
| | ARM 17.24.723 | Monitoring of vegetation, soils and wildlife. | Relevant and Appropriate |
| | ARM 17.24.724 | Success of revegetation shall be measured on the basis of unmined reference areas. | Relevant and Appropriate |
| | ARM 17.24.726 | Sets means of measuring productivity. | Relevant and Appropriate |
| | ARM 17.24.728 | Sets requirements for composition of vegetation. | Relevant and Appropriate |
| | ARM 17.24.730 and 731 | Revegetated area must furnish palatable forage in comparable quantity and quality during the same grazing period as the reference area. If toxicity to plants or animals is suspected, comparative chemical analysis may be required | Relevant and Appropriate |
| | ARM 17.24.733 | Sets requirements and measurement standards for trees, shrubs, and half-shrubs. | Relevant and Appropriate |

**TABLE 4-2 SUMMARY OF PRELIMINARY STATE APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (CONTINUED)**

| Standard, Requirement Criteria Or Limitation | Citation | Description | ARAR Status |
|---|---|---|---|
| Top Soiling, Revegetation, and Protection of Wildlife and Air Resource Regulations (continued) | ARM 17.24.751 | Required site activities must be conducted so as to avoid or minimize impacts to important fish and wildlife species, including critical habitat and any threatened and endangered species identified at the site. | Relevant and Appropriate |
| | ARM 17.24.761 | Section requires fugitive dust control measures for site preparation and reclamation operations. | Relevant and Appropriate |

# 5.0 RISK ASSESSMENT

Human and environmental health threats associated with exposure to mine waste characterized during Phase I and Phase II of the Silver Creek Drainage Project have been evaluated through a risk assessment process. The risks were evaluated in regards to site-specific chemical concentrations and applicable exposure pathways. This assessment follows risk assessment procedures for abandoned mine sites as developed by the DEQ-MWCB.

## 5.1 BASELINE HUMAN HEALTH RISK ASSESSMENT

The baseline human health risk assessment performed for the Phases I and II of the Silver Creek Drainage Project generally follows the Federal Remedial Investigation/Feasibility Study process for CERCLA (Superfund) sites (EPA, 1988). The baseline human health risk assessment examines the effects of taking no action at the site. This abbreviated assessment involves two steps: hazard identification and risk characterization. These tasks are accomplished by evaluating available data and selecting contaminants of concern (CoCs), and then characterizing overall risk by comparing the concentrations of CoCs in various media to previously derived cleanup goals. These previously derived cleanup goals include a risk assessment for recreational use at abandoned mine sites completed for the DEQ-MWCB (Tetra Tech, 1996) and the EPA Region III risk-based concentration table (Smith, 1996).

### 5.1.1 Hazard Identification

The objective of hazard identification is to identify the CoCs at the site that pose the greatest potential human health risk. Standard EPA criteria for this selection include: (1) those contaminants that are associated with and present at the site; (2) contaminants with average concentrations at least three times above background levels; (3) contaminants with at least 20% of the measured concentrations above the detection limit; and (4) contaminants with acceptable quality assurance/quality control results applied to the data.

Contaminants typically associated with mine and mill wastes include heavy metals and cyanide. Samples of mill tailings, waste rock, placer tailings, and soil collected from the Silver Creek Drainage Project area were laboratory analyzed for total cyanide and the following thirteen metal and non-metal elements: arsenic, barium, cadmium, cobalt, chromium, copper, iron, mercury, manganese, nickel, lead, antimony and zinc for Phase II waste sources or arsenic, cadmium, copper, mercury, lead and zinc for Phase I waste sources. Water samples used in the risk assessment were collected by Maxim Technologies in 1995 and 1996 (DEQ-MWCB/Maxim, 1996). These analyses were supplemented by screening for a multi-element suite using a portable x-ray fluorescence analyzer.

The Silver Creek Drainage Project area is large and includes a number of waste sources. Therefore, the site was divided into six subareas/waste source groups as presented in Table 5-1, and a risk assessment was completed on the waste sources in each group.

**TABLE 5-1 SILVER CREEK DRAINAGE PROJECT PHASES I AND II SUBAREAS AND WASTE SOURCE GROUPS**

| Project Subarea | Waste Source Group |
|---|---|
| Drumlummon Mine | WR-1 and WR-2 |
| Drumlummon Millsite | TP-1, TP-2, TP-3, mill foundation tailings, WR-3, WR-4 |
| Drumlummon tailings | Drumlummon tailings |
| Goldsil tailings | Goldsil tailings (GT and GM) |
| Upper, Lower and Middle Ponds | Upper Pond tailings, Middle Pond Lower Pond tailings, borrow sources BS-1 and BS-2 |
| Silver Creek Placer Tailings | Placer tailings |
| Silver Creek Stream Sediment | Stream sediment |

The average concentration and multiplier above background for the elements analyzed in each waste source are shown in Table 5-2. Mean total cyanide concentrations are presented in Table 5-2. The multiplier of cyanide above background was not calculated because total cyanide was not analyzed in background soil samples. The CoC's for each group were evaluated based on the criteria listed above and are shown in Table 5-3. Total cyanide is not expected to be detected in significant concentrations in background soil samples. Therefore, cyanide was included as a CoC if it was present in a given waste source.

Data collected by Maxim in 1995 and 1996 were used to evaluate CoCs for surface water. CoCs for surface water were selected based on exceedances of human health or Federal acute or chronic aquatic water standards. Cadmium, copper, lead, mercury, zinc and cyanide exceeded acute or chronic aquatic water quality criteria in Silver Creek. Arsenic, iron and manganese exceeded human health standards in Silver Creek. Iron and manganese exceeded human health standards at most of Maxim's sampling stations along Silver Creek. Arsenic only exceeded human health standards in samples collected below Birdseye Road, and did not exceed human health standards in the vicinity of the waste sources being evaluated as part of this EE/CA. Arsenic does not meet the CoC criteria in any of the waste sources. Therefore, arsenic will not be considered a CoC in the risk assessment.

### 5.1.2 Exposure Scenarios

The following section presents the exposure assessment conducted for the Silver Creek Drainage Project Phases I and II. The exposure assessment identifies the potentially exposed population(s) and exposure pathways and estimates exposure point concentrations and contaminant intakes. The previously derived risk-based cleanup goals were calculated using two exposure scenarios: a recreational use scenario (Tetra Tech, 1996) and a residential use scenario (Smith, 1996).

**Table 5-2. MEAN ELEMENT CONCENTRATIONS IN PROJECT SUBAREAS AND WASTE SOURCE GROUPS AND MULTIPLIER ABOVE BACKGROUND CONCENTRATIONS**

| Sample ID | Ag (mg/Kg) | As (mg/Kg) | Ba (mg/Kg) | Cd (mg/Kg) | Cr (mg/Kg) | Cu (mg/Kg) | Fe (mg/Kg) | Hg (mg/Kg) | Mn (mg/Kg) | Ni (mg/Kg) | Pb (mg/Kg) | Sb (mg/Kg) | Zn (mg/Kg) | CN (mg/Kg) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Drumlummon Mine** | | | | | | | | | | | | | | |
| Waste Rock | ND | 7 | 52 | ND | 14 | 53 | 15000 | ND | 442 | 8 | 12 | ND | 46 | NA |
| | | 0.33 x | 0.36 x | | 1.17 x | 1.55 x | 1.09 x | | 0.88 x | 0.89 x | 1.06 x | | 0.67 x | |
| **Drumlummon Millsite** | | | | | | | | | | | | | | |
| Waste Rock | 5 | 27 | 107 | ND | 10 | 52 | 12100 | 2 | 416 | 9 | 67 | 6 | 86 | NA |
| | 2.00 x | 1.26 x | 0.74 x | | 0.83 x | 1.52 x | 0.88 x | 4.00 x | 0.83 x | 1.00 x | 5.91 x | 1.25 x | 1.25 x | |
| Mill Tailings | 8.0 | 28 | 88.0 | ND | 11.0 | 97.6 | 10600.0 | 4.1 | 474 | 2.5 | 117.2 | 10.0 | 180.6 | 5.7 |
| | 3.20 x | 1.31 x | 0.61 x | | 0.92 x | 2.86 x | 0.77 x | 8.20 x | 0.94 x | 0.28 x | 10.34 x | 2.08 x | 2.62 x | |
| **Drumlummon Tailings** | | | | | | | | | | | | | | |
| Mill Tailings | 16.4 | 11.7 | 47.4 | ND | 7.1 | 62.4 | 7684 | 0.7 | 438.2 | 3.9 | 54.4 | 5 | 102.6 | ND |
| | 6.56 x | 0.55 x | 0.33 x | | 0.59 x | 1.83 x | 0.56 x | 1.40 x | 0.87 x | 0.43 x | 4.80 x | 1.04 x | 1.49 x | |
| **Goldsil Tailings** | | | | | | | | | | | | | | |
| Mill Tailings | 19.3 | 31.8 | 48.4 | 3.1 | 3.3 | 171.2 | 6606.7 | 50.7 | 699.4 | ND | 181.8 | 15.0 | 354.3 | 3.5 |
| | 7.70 x | 1.49 x | 0.33 x | 6.21 x | 0.27 x | 5.01 x | 0.48 x | 101.37 x | 1.39 x | | 16.04 x | 3.13 x | 5.15 x | |
| **Upper, Middle, Lower Ponds** | | | | | | | | | | | | | | |
| Mill Tailings | NA | 28.9 | NA | 2.6 | NA | 141.3 | NA | 38.9 | NA | NA | 147 | NA | 300.0 | 5.9 |
| | | 1.35 x | | 5.14 x | | 4.13 x | | 77.75 x | | | 12.97 x | | 4.36 x | |
| **Silver Creek Placer Tailings** | | | | | | | | | | | | | | |
| Placer Tailings | NA | 28.4 | NA | ND | NA | 28.9 | NA | 3.8 | NA | NA | 21.6 | NA | 56.0 | ND |
| | | 1.33 x | | | | 0.85 x | | 7.60 x | | | 1.91 x | | 0.81 x | |
| **Silver Creek Sediment** | | | | | | | | | | | | | | |
| | NA | 10.4 | NA | NC [b] | NA | 43.2 | NA | 5.9 | NA | NA | 40.8 | NA | 76.2 | NC [b] |
| | | 0.49 x | | NC [b] | | 1.26 x | | 11.74 x | | | 3.60 x | | 1.11 x | NC [b] |
| **Mean Background** | | | | | | | | | | | | | | |
| | 2.5 [a] | 21.4 | 145 | 0.5 [a] | 12 | 34.2 | 13700 | 0.5 [a] | 504.0 | 9.0 | 11.3 | 4.8 | 68.8 | |

x multiplier above mean background (x times greater than the mean)
[a] concentration less than lower detection limit; one half of lower detection used for calculation
[b] Less than 20% of the measured concentrations above the method detection limit
NA not analyzed
NC not calculated
ND concentration less than lower detection limit

**TABLE 5-3 CONTAMINANTS OF CONCERN BY PROJECT SUBAREA AND WASTE TYPE**

| Project Subarea and Waste Source | CoCs |
|---|---|
| Drumlummon Mine - Waste Rock | None |
| Drumlummon Millsite - Waste Rock | Hg, Pb |
| Drumlummon Millsite - Tailings | Ag, Hg, Pb, CN |
| Drumlummon tailings (DT) | Ag, Pb |
| Goldsil tailings | Ag, Cd, Cu, Hg, Pb, Sb, Zn, CN |
| Upper, Lower and Middle Ponds* - tailings | Cd, Cu, Hg, Pb, Zn, CN |
| Silver Creek Placer Tailings | Hg |
| Silver Creek Sediment | Hg, Pb |

*CoCs for Borrow Sources BS-1 and BS-2 evaluated with Silver Creek Placer Tailings

The residential use risk-based concentrations involve residential occupation of the contaminated land with the maximum level of exposure occurring for a child 0-6 years old (soil ingestion route). The resultant risk-based concentrations were derived for this worst-case residential exposure scenario by EPA Region III (Smith, 1996). The soil ingestion, dust inhalation exposure routes and drinking water ingestion exposure were based on the soil and water concentrations presented in Table 5-4.

The waste sources in the Silver Creek Drainage Project are primarily located on patented mining claims, however, there is abundant public and private land adjoining the mining claims. It should be noted that the access to the waste sources is virtually unrestricted. There are gates across the access roads to the Drumlummon tailings, Goldsil tailings and the Upper, Middle and Lower Pond area, however, the gates are not locked. Current human exposure to site-related contaminants is primarily related to recreational activities proceeding on and near the site.

The DEQ-MWCB has provided a measure of the health risks to recreational populations exposed to mine wastes in a report titled "Risk-based Cleanup Guidelines for Abandoned Mine Sites" (Tetra Tech, 1996). The risk-based guidelines were developed using a risk assessment that assumed four types of recreation populations: fishermen, hunters, gold panners/rockhounds and ATV/motorcycle riders. Field observations suggests that each of these uses has the propensity to occur in the Silver Creek Drainage Project area. Therefore, the exposed populations used in developing the DEQ-MWCB risk-based guidelines appear to be applicable to exposures that could reasonably be expected within the Silver Creek Drainage Project area. The maximum risk calculated for the applicable recreational exposure scenarios was for: 1) an ATV/motorcycle rider (mill tailings only); or 2) a rockhound/gold panner (waste rock, placer tailings and surface water only), or 3) a downstream fisherman (fish consumption only). A high level of recreational use was assumed for this site based on observations made during collection of data in 1993 for the DEQ-MWCB Abandoned Inactive Mine Scoring System (AIMSS), field observations during site characterization in 2002, and the relatively unrestricted site access. The soil ingestion and dust inhalation exposure routes for the ATV/motorcycle rider assumed a surface concentration equal to the average of near surface tailings samples collected from the Drumlummon millsite tailings, Drumlummon tailings, Goldsil tailings or the Upper, Middle and Lower Ponds, respectively. The soil ingestion and dust inhalation exposure routes for the rockhound/gold panner assumed a concentration equal to the waste rock sample collected from WR3 and WR4 for the Drumlummon millsite, the maximum near-surface concentrations in tailings for the Goldsil tailings, the maximum concentration from samples collected from borrow sources BS1 and BS-2 (overburden placer tailings piles) for the Upper, Middle and Lower Pond area, or the maximum concentration of samples from placer tailings for the Silver Creek Placer Tailings area. The water ingestion route assumed the maximum measured water concentrations for sample SW-02 for the Drumlummon millsite, SW-06 for the Drumlummon tailings, SW-07 for the Goldsil tailings and the Upper, Middle and Lower Pond areas and SW-09 for the Silver Creek placer tailings area.

**TABLE 5-4 SOIL AND WATER CONCENTRATIONS USED TO EVALUATE RESIDENTIAL EXPOSURES**

| Project Subarea | Soil Ingestion and Dust Inhalation | Drinking Water Ingestion |
|---|---|---|
| Drumlummon Millsite | Maximum concentrations observed in the millsite tailings piles from samples collected by Olympus in 2002. | Maximum concentrations from surface water sample SW-02 near Marysville or from the main Drumlummon adit discharge collected by Maxim in 1995 and 1996. |
| Drumlummon tailings | Average of near surface soil samples collected by Olympus from test pits in 2002. Sample depths ranged from 0 to <6 feet. | Maximum concentrations from surface water sample SW-06 just downstream from the Drumlummon tailings collected by Maxim in 1995 and 1996. |
| Goldsil tailings | Average of near surface soil samples collected by Olympus from test pits in 2002. Sample depths ranged from 0 to <10 feet. | Maximum concentrations from surface water sample SW-07 just downstream from the Goldsil tailings collected by Maxim in 1995 and 1996. |
| Upper, Lower and Middle Ponds | Average of near surface soil samples collected by Olympus from test pits in 2002. Sample depths ranged from 0 to <5 feet. | Maximum concentrations from surface water sample SW-09 downstream from the Birdseye Road collected by Maxim in 1995 and 1996. |
| Silver Creek placer tailings | Maximum concentrations observed in the placer tailings piles from samples collected by Olympus in 2002. | Maximum concentrations from surface water sample SW-09 downstream from the Birdseye Road collected by Maxim in 1995 and 1996. |

### 5.1.3 Toxicity Assessment

The toxicity assessment examines the potential for CoCs to cause adverse effects in exposed individuals and provides an estimate of the dose-response relationship between the extent of exposure to a particular contaminant and adverse effects. Adverse effects include both carcinogenic and noncarcinogenic health effects in humans. Sources of toxicity data include EPA's Integrated Risk Information System (IRIS, EPA, 1995), Agency for Toxic Substances and Disease Registry (ATSDR) Toxicological Profiles, Health Effects Assessment Summary Tables

(HEAST), and EPA criteria documents. Individual toxicity profiles for each CoC are not presented here, however, they are provided in the reference documents (Smith, 1996, Tetra Tech, 1996). The existing risk-based concentrations that were used to characterize risks from exposure to the CoCs for each exposure scenario are presented in Tables 5-5 and 5-6 for residential and recreational scenarios, respectively. The risk values correspond to a lifetime cancer risk of $1x10^{-6}$ (one in one million) or hazard quotients equal to 1.

**TABLE 5-5 RISK-BASED CONCENTRATIONS FOR CONTAMINANTS OF CONCERN FOR THE RESIDENTIAL SCENARIO**

| Contaminant of Concern | Residential Soil Ingestion (soil conc.) (mg/Kg) | Residential Dust Inhalation (soil conc.) (mg/Kg) | Residential Water Ingestion (ug/l) |
|---|---|---|---|
| Antimony | 31 | NA | 15 |
| Cadmium | 39 (Noncarc) | 920 (Noncarc)<br>920 (Carc) | 18 |
| Copper | 3100 | NA | 1500 |
| Lead | 400* | NA | 15* |
| Mercury | 23 | 7 | 11 |
| Silver | 390 | NA | 180 |
| Zinc | 23000 | NA | 11000 |
| Cyanide | 1600 | NA | 730 |

NA = Not available
Noncarc = Noncarcinogenic
Carc = Carcinogenic
*Lead levels derived from EPA recommendations, not RBC table (Smith, 1996).

**TABLE 5-6 RISK-BASED CONCENTRATIONS FOR CONTAMINANTS OF CONCERN FOR THE RECREATIONAL SCENARIO, MAXIMUM USE SCENARIO**

| Contaminant of Concern | Recreational Soil Ingestion/Inhalation Waste Rock (mg/Kg) | Recreational Soil Ingestion/Inhalation Tailings (mg/Kg) | Recreational Water Ingestion (ug/l) | Recreational Fish Ingestion (water conc.) (ug/l) |
|---|---|---|---|---|
| Antimony | 586 | 1040 | 204 | 2150 |
| Cadmium | 1750 (Noncarc) | 3150 (Noncarc)<br>38.9 (Carc) | 256 | 66.5 |
| Copper | 54200 | 96600 | 18900 | 996 |
| Cyanide | 11100 | 19300 | 10200 | NA |
| Lead | 2200 | 3920 | 220 | 165 |
| Mercury | 440 | 738 | 153 | 0.294 |
| Silver | NA | NA | NA | NA |
| Zinc | 440000 | 784000 | 153000 | 34400 |

Noncarc = Noncarcinogenic @ HQ=1
Carc = Carcinogenic @ Risk $=1.0X10^{-6}$
NA - Not Applicable

### 5.1.4 Risk Characterization

#### 5.1.4.1 Residential Land Use Scenario

The residential exposure assumptions utilized to estimate contaminant intakes were compared to the risk-based concentrations (RBCs) in Table 5-5. These data were used to calculate resultant human health noncarcinogenic Hazards Quotients (HQs) and carcinogenic risk values for each CoC. The results of the risk calculations for the residential land use scenario in the Silver Creek Drainage Project subareas are summarized in Tables 5-7 through 5-11.

HQ values exceed one for the residential land use scenario for the following CoCs at the following locations:

- lead (1.033) and mercury (1.695) at the Drumlummon millsite;
- mercury (1.313) at the Silver Creek placer tailings;
- mercury (8.776) at the Goldsil tailings; and
- mercury (5.115) at the Upper, Middle and Lower Ponds.

Mercury exceeds the HQ values of 1 for dust inhalation at the Drumlummon millsite (1.286) and Silver Creek placer tailings (1.00004). Mercury exceeds the HQ values of 1 for soil ingestion and dust inhalation at the Goldsil tailings (2.043 and 6.714, respectively) and the Upper, Middle and Lower Ponds (1.191 and 3.914, respectively). None of the CoCs exceeded the HQ of 1 for water ingestion. HQ values greater than one indicate the potential for harmful effects by a CoC via the specified pathway.

The lower part of Tables 5-7 through 5-11 presents carcinogenic risk. Only arsenic and cadmium have carcinogenic RBCs. Arsenic is not a CoC in the Silver Creek Drainage Project area and cadmium is a CoC only at the Goldsil tailings and the Upper, Middle and Lower Ponds areas. The carcinogenic risks for cadmium are 3.4E-09 and 2.6E-09 at the Goldsil tailings and the Upper, Middle and Lower Ponds areas, respectively. The EPA utilizes a 1.0E-06 value as a point of departure in assessing the need for contaminant cleanup at a particular site. These site values do not exceed the EPA point of departure.

#### 5.1.4.2 Recreational Land Use Scenario

The recreational exposure assumptions utilized to estimate contaminant intakes were compared to the risk-based concentrations in Table 5-6. These data were used to calculate resultant human health carcinogenic risk values and noncarcinogenic HQs for each CoC. The results of the risk calculations for the recreational land use scenario in the Silver Creek Drainage Project area are summarized in Tables 5-12 through 5-16.

Within the recreational land use scenario, only the CoC mercury at the Drumlummon tailings exceeded an HQ value of 1 via fish ingestion. As a result, reclamation alternatives should address this exposure pathway. The source of elevated mercury is most likely the result of past processing at the Drumlummon mill. A book on ore processing (Richards, 1903) indicates that,

**Table 5-7. Summary of Noncarcinogenic Hazard Quotients (HQs) and Carcinogenic Risk Values for the Residential Land Use Scenario – Drumlummon Millsite Tailings**

| Contaminant of Concern | Soil Ingestion | Dust Inhalation | Water Ingestion | Total HQ by CoC |
|---|---|---|---|---|
| Noncarcinogenic HQ Summary | | | | |
| Cyanide | 0.01550 | NC | 0.00342 | 0.01892 |
| Lead | 0.43250 | 0.00017 | 0.60000 | 1.03267 |
| Mercury | 0.39130 | 1.28571 | 0.01818 | 1.69520 |
| Silver | 0.02051 | NC | NA | 0.02051 |
| Total HQ | 0.85982 | 1.28589 | 0.62161 | 2.76731 |
| | | | | |
| Carcinogenic Risk Summary | | | | |
| No Carcogenic CoCs | | | | |
| Total Risk | | | | 0.0E+00 |

NC - Not Calculated because no RBC provided in Smith, 1996
NA - silver was not detected in surface water.

**Table 5-8. Summary of Noncarcinogenic Hazard Quotients (HQs) and Carcinogenic Risk Values for the Residential Land Use Scenario – Drumlummon Tailings**

| Contaminant of Concern | Soil Ingestion | Dust Inhalation | Water Ingestion | Total HQ by CoC |
|---|---|---|---|---|
| Noncarcinogenic HQ Summary | | | | |
| Lead | 0.13750 | 0.00006 | 0.33333 | 0.47089 |
| Mercury | 0.03261 | 0.10714 | 0.03636 | 0.17612 |
| Silver | 0.03077 | NC | NA | 0.03077 |
| Total HQ | 0.20088 | 0.10720 | 0.36970 | 0.67777 |
| | | | | |
| Carcinogenic Risk Summary | | | | |
| No Carcogenic CoCs | | | | |
| Total Risk | | | | 0.0E+00 |

NA - silver was not detected in surface water
NC - Not Calculated because no RBC provided in Smith, 1996

**Table 5-9. Summary of Noncarcinogenic Hazard Quotients (HQs) and Carcinogenic Risk Values for the Residential Land Use Scenario – Silver Creek Placer Tailings**

| Contaminant of Concern | Soil Ingestion | Dust Inhalation | Water Ingestion | Total HQ by CoC |
|---|---|---|---|---|
| Noncarcinogenic HQ Summary | | | | |
| Lead | 0.11000 | 0.00004 | 0.06667 | 0.17671 |
| Mercury | 0.30435 | 1.00000 | 0.00909 | 1.31344 |
| Total HQ | 0.41435 | 1.00004 | 0.07576 | 1.49015 |
| | | | | |
| Carcinogenic Risk Summary | | | | |
| No Carcogenic CoCs | | | | |
| Total Risk | | | | 0.0E+00 |

**Table 5-10. Summary of Noncarcinogenic Hazard Quotients (HQs) and Carcinogenic Risk Values for the Residential Land Use Scenario – Goldsil Tailings**

| Contaminant of Concern | Soil Ingestion | Dust Inhalation | Water Ingestion | Total HQ by CoC |
|---|---|---|---|---|
| Noncarcinogenic HQ Summary | | | | |
| Antimony | 0.49355 | NC | NA | 0.49355 |
| Cadmium | 0.07949 | 0.00337 | 0.00556 | 0.08841 |
| Copper | 0.05323 | NC | 0.00200 | 0.05523 |
| Cyanide | 0.00306 | NC | 0.00342 | 0.00649 |
| Lead | 0.45050 | 0.00018 | 0.20000 | 0.65068 |
| Mercury | 2.04348 | 6.71429 | 0.00909 | 8.76685 |
| Silver | 0.03462 | NC | 0.00000 | 0.03462 |
| Zinc | 0.01588 | NC | 0.00727 | 0.02315 |
| Total HQ | 3.17380 | 6.71784 | 0.22734 | 10.11898 |

| Carcinogenic Risk Summary | | | | |
|---|---|---|---|---|
| Cadmium | NC | 3.4E-09 | NC | 3.4E-09 |
| Total Risk | | 3.4E-09 | | 3.4E-09 |

NC - Not Calculated because no RBC provided in Smith, 1996
NA - antimony was not analyzed in surface water

**Table 5-11. Summary of Noncarcinogenic Hazard Quotients (HQs) and Carcinogenic Risk Values for the Residential Land Use Scenario – Upper, Middle and Lower Ponds**

| Contaminant of Concern | Soil Ingestion | Dust Inhalation | Water Ingestion | Total HQ by CoC |
|---|---|---|---|---|
| Noncarcinogenic HQ Summary | | | | |
| Cadmium | 0.06154 | 0.00261 | 0.00556 | 0.06970 |
| Copper | 0.04097 | NC | 0.00533 | 0.04630 |
| Cyanide | 0.00255 | NC | 0.01233 | 0.01488 |
| Lead | 0.33000 | 0.00013 | 0.06667 | 0.39680 |
| Mercury | 1.19130 | 3.91429 | 0.00909 | 5.11468 |
| Zinc | 0.01145 | NC | 0.01000 | 0.02145 |
| Total HQ | 1.63781 | 3.91703 | 0.10898 | 5.66381 |

| Carcinogenic Risk Summary | | | | |
|---|---|---|---|---|
| Cadmium | NC | 2.6E-09 | NC | 2.6E-09 |
| Total Risk | | 2.6E-09 | | 2.6E-09 |

NC - Not Calculated because no RBC provided in Smith, 1996

**Table 5-12 Summary of Noncarcinogenic Hazard Quotients (HQs) and Carcinogenic Risk Values for the Recreational Land Use Scenario - Drumlummon Millsite**

| Contaminant of Concern | Soil Ingestion/ Dust Inhalation for Rockhounds and Gold Panners in Waste Rock | Soil Ingestion/ Dust Inhalation for ATV and Motorcycle Riders in Tailings | Water Ingestion Rockhounds and Gold Panners in Spring Creek | Fisherman Fish Ingestion |
|---|---|---|---|---|
| Noncarcinogenic HQ Summary | | | | |
| Cyanide | NA | 0.0012850 | 0.0002451 | 0.00000250 |
| Lead | 0.0304545 | 0.0441327 | 0.0409091 | 0.05454545 |
| Mercury | 0.0045455 | 0.0121951 | 0.0013072 | 0.68027211 |
| Silver | 0.0000050 | 0.0000080 | 0.0000000 | 0.00000000 |
| Total HQ | 0.0350050 | 0.0576207 | 0.0424614 | 0.73482006 |
| | | | | |
| Carcinogenic Risk Summary | | | | |
| No Carcogenic CoCs | | | | |
| Total Risk | | | | 0.0E+00 |

NA - Cyanide not analyzed in waste rock

**Table 5-13 Summary of Noncarcinogenic Hazard Quotients (HQs) and Carcinogenic Risk Values for the Recreational Land Use Scenario - Drumlummon Tailings**

| Contaminant of Concern | Soil Ingestion/ Dust Inhalation for Rockhounds and Gold Panners in Waste Rock | Soil Ingestion/ Dust Inhalation for ATV and Motorcycle Riders in Tailings | Water Ingestion Rockhounds and Gold Panners in Spring Creek | Fisherman Fish Ingestion |
|---|---|---|---|---|
| Noncarcinogenic HQ Summary | | | | |
| Lead | 0.02500 | 0.01403 | 0.02273 | 0.03030 |
| Mercury | 0.01364 | 0.00102 | 0.00261 | 1.36054 |
| Silver | 0.00001 | 0.00001 | NA | NA |
| Total HQ | 0.03865 | 0.01506 | 0.02534 | 1.39085 |
| | | | | |
| Carcinogenic Risk Summary | | | | |
| No Carcogenic CoCs | | | | |
| Total Risk | | | | 0.0E+00 |

NA - Silver was not detected in water

**Table 5-14 Summary of Noncarcinogenic Hazard Quotients (HQs) and Carcinogenic Risk Values for the Recreational Land Use Scenario - Silver Creek Placer Tailings**

| Contaminant of Concern | Soil Ingestion/ Dust Inhalation for Rockhounds and Gold Panners in Waste Rock | Soil Ingestion/ Dust Inhalation for ATV and Motorcycle Riders in Tailings | Water Ingestion Rockhounds and Gold Panners in Spring Creek | Fisherman Fish Ingestion |
|---|---|---|---|---|
| Noncarcinogenic HQ Summary | | | | |
| Lead | 0.02000 | 0.01122 | 0.00455 | 0.00606 |
| Mercury | 0.01591 | 0.00949 | 0.00065 | 0.34014 |
| Total HQ | 0.03591 | 0.02071 | 0.00520 | 0.34620 |
| | | | | |
| Carcinogenic Risk Summary | | | | |
| No Carcogenic CoCs | | | | |
| Total Risk | | | | 0.0E+00 |

**Table 5-15 Summary of Noncarcinogenic Hazard Quotients (HQs) and Carcinogenic Risk Values for the Recreational Land Use Scenario - Goldsil Tailings**

| Contaminant of Concern | Soil Ingestion/ Dust Inhalation for Rockhounds and Gold Panners in Waste Rock | Soil Ingestion/ Dust Inhalation for ATV and Motorcycle Riders in Tailings | Water Ingestion Rockhounds and Gold Panners in Spring Creek | Fisherman Fish Ingestion |
|---|---|---|---|---|
| Noncarcinogenic HQ Summary | | | | |
| Antimony | 0.02611 | 0.01471 | NA | NA |
| Cadmium | 0.00177 | 0.00098 | 0.00039 | 0.00150 |
| Copper | 0.00304 | 0.00171 | 0.00016 | 0.00301 |
| Cyanide | 0.00044 | 0.00025 | 0.00025 | 0.00000 |
| Lead | 0.08191 | 0.04597 | 0.01364 | 0.01818 |
| Mercury | 0.10682 | 0.06369 | 0.00065 | 0.34014 |
| Silver | 0.00001 | 0.00001 | NA | NA |
| Zinc | 0.00083 | 0.00047 | 0.00052 | 0.00233 |
| Total HQ | 0.22094 | 0.12779 | 0.01561 | 0.36516 |
| | | | | |
| Carcinogenic Risk Summary | | | | |
| Cadmium | NC | 8.0E-08 | NC | NC |
| Total Risk | -- | 8.0E-08 | -- | -- |

NC - Not Calculated because no RBC provided in Smith, 1996
NA - Antimony was not analyzed in surface water and silver was not detected in surface water.

**Table 5-16 Summary of Noncarcinogenic Hazard Quotients (HQs) and Carcinogenic Risk Values for the Recreational Land Use Scenario - Upper, Middle and Lower Ponds**

| Contaminant of Concern | Soil Ingestion/ Dust Inhalation for Rockhounds and Gold Panners in Waste Rock | Soil Ingestion/ Dust Inhalation for ATV and Motorcycle Riders in Tailings | Water Ingestion Rockhounds and Gold Panners in Spring Creek | Fisherman Fish Ingestion |
|---|---|---|---|---|
| Noncarcinogenic HQ Summary | | | | |
| Cadmium | 0.00029 | 0.00076 | 0.00039 | 0.00150 |
| Copper | 0.00063 | 0.00131 | 0.00042 | 0.00803 |
| Cyanide | 0.00002 | 0.00021 | 0.00088 | 0.00001 |
| Lead | 0.00955 | 0.03367 | 0.00455 | 0.00606 |
| Mercury | 0.00682 | 0.03713 | 0.00065 | 0.34014 |
| Zinc | 0.00014 | 0.00034 | 0.00072 | 0.00320 |
| Total HQ | 0.01744 | 0.07342 | 0.00761 | 0.35894 |
| | | | | |
| Carcinogenic Risk Summary | | | | |
| Cadmium | NC | 6.2E-08 | NC | NC |
| Total Risk | -- | 6.2E-08 | -- | -- |

NC - Not Calculated because no RBC provided in Smith, 1996 in the early days of the Drumlummon mill, approximately 0.5 pounds of mercury per ton of ore were used in the Combination Mill (an older mill at the Drumlummon site). At this rate, approximately 10 tons of mercury would have been discharged to the tailings per year. This is supported by studies completed by the Montana Department of Fish, Wildlife and Parks (MDFWP and MDHES, 1994 and MDFWP, 1984) that have shown elevated levels of mercury in the tissue of fish in Silver Creek (Section 3.7). No other CoCs exceeded an HQ value of 1 for the specified exposure pathways.

The lower part of Tables 5-12 through 5-16 presents carcinogenic risk. Only arsenic and cadmium have carcinogenic RBCs. Arsenic is not a CoC in the Silver Creek Drainage Project area and cadmium is a CoC only at the Goldsil tailings and the Upper, Middle and Lower Ponds areas. The carcinogenic risks for cadmium are 8.0E-08 and 6.2E-08 at the Goldsil tailings and the Upper, Middle and Lower Ponds areas, respectively, for ATV/motorcycle use on the tailings pile. The EPA utilizes a 1.0E-06 value as a point of departure in assessing the need for contaminant cleanup at a particular site. These site values do not exceed the EPA threshold.

## 5.2 ECOLOGICAL RISK ASSESSMENT

### 5.2.1 Introduction

The ecological risk assessment was performed for the Silver Creek Drainage Project Phase I and Phase II areas following Federal RI/FS guidance for CERCLA (Superfund) sites (EPA, 1988a). The key guidance documents used were EPA's Risk Assessment Guidance for Superfund, Volume II, Environmental Evaluation Manual (EPA, 1989b), and Ecological Assessment of Hazardous Waste Sites (EPA, 1989c). The waste materials present at the site pose a potential risk not only to humans, but also to other species that come into contact with them. Due to the sparse and indirect nature of the ecologic risk data available for the site, this evaluation is intended as a screening-level ecological risk assessment, and the results are of a qualitative nature.

The ecological risk assessment estimates the effects of taking no action at the site and involves four steps: 1) identification of contaminants and ecologic receptors of concern; 2) exposure assessment; 3) ecologic effects assessment; and 4) risk characterization. These four tasks are accomplished by evaluating available data and selecting contaminants, species and exposure routes of concern, estimating exposure point concentrations and intakes, assessing ecologic toxicity of the CoCs, and characterizing overall risk by integrating the results of the toxicity and exposure assessments.

Problems in the Silver Creek Drainage Project area that could impact ecologic receptors include elevated concentrations of metals in waste materials on-site (mill tailings, waste rock piles, and placer tailings) and elevated concentrations of metals in surface water and stream sediments downgradient from the site. The easily accessible waste materials may result in significant ecological effects; the objective of this ecological risk assessment is to estimate current and future effects of implementing the no-action alternative in the Silver Creek Drainage Project area.

### 5.2.2 Contaminants of Concern

As in the human health risk assessment, contaminants that are significantly above background concentrations and are associated with the site are retained as CoCs. The CoCs for the different project subareas are presented in Table 5-3. These contaminants are characteristic of hardrock mining wastes and represent contamination reliably associated with site activities. However, several of these contaminants have no ecologic toxicity data with which to evaluate potential effects.

Three groups of ecologic receptors have been identified as potentially affected by site contamination. The first group of receptors are those associated with Silver Creek and include fisheries, aquatic life and wetlands. These surface water receptors are evaluated using USEPA aquatic life criteria, which apply to aquatic organisms only; there are no criteria with which to evaluate wetlands.

The second group of receptors are terrestrial wildlife that may use this area as part of their summer range, including deer and elk. The possibility exists for use by wildlife, both for water and for consumption of evaporative salts that can form on the wastes. This poses a potential for contaminant accumulation and subsequent health effects in the wildlife populations that visit the site. The only terrestrial wildlife receptor evaluated are deer which probably represent the highest level of exposure to site contaminants; the effects to deer can be assumed to apply to other wildlife receptors.

The third group of receptors are native terrestrial plant communities, which are noticeably absent on some of the waste sources in the Silver Creek Drainage Project area. They are of concern because the absence of vegetation enhances erosion and exposure to the wastes by potential human and wildlife receptors.

### 5.2.3 Exposure Assessment

The three exposure scenarios can be semi-quantitatively assessed, however, only the deer ingestion of salts and water scenario involves the calculation of a dose. Both the surface water aquatic life and plant phytotoxicity can be compared directly to existing toxicity standards that apply to environmental media.

#### 5.2.3.1 Surface Water/Sediment - Aquatic Life Scenario

Ecologic exposures via this pathway are threefold: 1) direct exposure of aquatic organisms to surface water concentrations that exceed toxicity thresholds; 2) ingestion of aquatic species (e.g. insects) that have bioaccumulated contaminants to the extent that they are toxic to the predator (e.g. fish); and 3) exposure of aquatic organisms (e.g. fish embryos) to sediment pore water environments that are toxic due to elevated contaminant concentrations in the sediments. Sediment data used for this assessment were collected from Silver Creek during the site characterization in 2002. Water data were collected in Spring Creek during 1995 and 1996 by Maxim (DEQ-AMRB/Maxim, 1996). Selected water quality and sediment concentration data are presented in Tables 5-17 and 5-18.

## TABLE 5-17 MAXIMUM CONTAMINANT CONCENTRATIONS IN SURFACE WATER

| Project Subarea | Concentration in Surface Water (ug/l) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Ag | Cd | Cu | Hg | Pb | Sb | Zn | CN |
| Drumlummon Millsite (SW-02) | ND | NC | NC | 0.2 | 9 | NC | NC | 2.5 |
| Drumlummon tailings (SW-06) | ND | NC | NC | 0.4 | 5 | NC | NC | NA |
| Goldsil tailings (SW-07) | ND | 4 | 5 | 0.2 | 3 | NA | 80 | 2.5 |
| Upper, Lower and Middle Ponds (SW-09) | NC | 0.1 | 8 | 0.1 | 1 | NC | 110 | 9 |
| Silver Creek Placer Tailings (SW-09) | NC | NC | NC | 0.1 | 1 | NC | NC | NC |

NC - Not a contaminant of concern in this project subarea
ND - below laboratory detection limits
NA - not analyzed

## TABLE 5-18 MAXIMUM CONTAMINANT CONCENTRATIONS IN STREAM SEDIMENT

| Project Subarea | Concentration in Stream Sediment (mg/Kg) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Ag | Cd | Cu | Hg | Pb | Sb | Zn |
| Drumlummon Millsite (Reaches 2-3) | NA | NC | NC | 14 | 76 | NC | NC |
| Drumlummon tailings (Reach 6) | NA | NC | NC | 6 | 42 | NC | NC |
| Goldsil tailings (Reaches 7-8) | NA | 0.5 | 164 | 30 | 154 | NA | 215 |
| Upper, Lower and Middle Ponds (Reaches 9-10) | NC | 0.5 | 58 | 10 | 39 | NC | 85 |
| Silver Creek Placer Tailings (Reaches 11-13) | NC | NC | NC | 23 | 62 | NC | NC |

NC - Not a contaminant of concern in this project subarea
ND - below laboratory detection limits
NA - not analyzed

### 5.2.3.2 Deer Ingestion Scenario

Wildlife salt uptake data provided in "Elk of North America" ranges from 1 to 11 pounds in one month for a herd of 50 to 75 elk (USDA, 1995). Using a median exposure (non-conservative) approach, the average salt usage (6 pounds/month) was divided by the average herd size (63) for an average individual salt uptake of 0.0032 pounds/day, or 0.00144 Kilograms/day (Kg/day). This intake is modified by the uptake of an additional 50% (0.00072 Kg/day) of non-salt wastes associated with the evaporative salt deposits at the site and then divided in half to account for the lower body weight of deer with respect to elk, for a total uptake of 0.0011 Kg/day. The salts are assumed to have the same concentrations as the tailings, since they are solubilized and reprecipitated from minerals in the tailings. For the purpose of this calculation, the concentration data used were the same as those presented for soil and drinking water ingestion in Table 5-4. The average deer is assumed to weigh 150 pounds (68 Kg) and consume 10 liters of water per day. The data used to estimate the total deer intake dose is summarized in Table 5-19.

**TABLE 5-19 DEER INTAKE DOSE ESTIMATES**

| | Water Ingestion (ug/l) | | | |
|---|---|---|---|---|
| **Project Subarea** | **Cd** | **Cu** | **Pb** | **Zn** |
| Drumlummon Millsite | NC | NC | 9 | NC |
| Drumlummon tailings | NC | NC | 5 | NC |
| Goldsil tailings | 4 | 5 | 3 | 80 |
| Upper, Lower and Middle Ponds | 1 | 8 | 1 | 110 |
| Silver Creek Placer Tailings | NC | NC | 1 | NC |
| | **Wastes and Salts (mg/Kg)** | | | |
| **Project Subarea** | **Cd** | **Cu** | **Pb** | **Zn** |
| Drumlummon Millsite | NC | NC | 173 | NC |
| Drumlummon tailings | NC | NC | 55 | NC |
| Goldsil tailings | 3.1 | 165 | 180.2 | 365.2 |
| Upper, Lower and Middle Ponds | 2.4 | 127 | 132 | 263.4 |
| Silver Creek Placer Tailings | NC | NC | 44 | NC |
| Total Intake Dose (mg/Kg/day) | 0.0001 | 0.0032 | 0.0033 | 0.0204 |

NC - Not a contaminant of concern in this project subarea

### 5.2.3.3 Plant - Phytotoxicity Scenario

This scenario involves the limited ability of various plant species to grow in soil or wastes with high concentrations of site-related contaminants. Table 5-20 summarizes concentrations measured in waste materials in the Silver Creek Drainage Project area during the 2002 characterization investigation.

**TABLE 5-20 CONTAMINANT CONCENTRATIONS IN TAILINGS ON-SITE (mg/Kg)**

| **Project Subarea** | **Ag** | **Cd** | **Cu** | **Hg** | **Pb** | **Zn** |
|---|---|---|---|---|---|---|
| Drumlummon Millsite | 8 | NC | NC | 9 | 173 | NC |
| Drumlummon tailings | 12 | NC | NC | 0.75 | 55 | NC |
| Goldsil tailings | 13.5 | 3.1 | 165 | 47 | 180.2 | 365.2 |
| Upper, Lower and Middle Ponds | NC | 2.4 | 127 | 27.4 | 132 | 263.4 |
| Silver Creek Placer Tailings | NC | NC | NC | 7 | 44 | NC |

NC - Not a contaminant of concern in this project subarea
Concentrations in mg/Kg as defined in Table 5-4

### 5.2.4 Ecological Effects Assessment

The known effects of the site CoCs are available from several literature sources and are not repeated here. No site-specific toxicity tests were performed to support the ecologic risk assessment, either in-situ or at a laboratory. Only existing and proposed toxicity-based criteria and standards were used for this ecological effects assessment.

#### 5.2.4.1 Surface Water/Sediment - Aquatic Life Scenario

Freshwater acute (1-hour average) water quality criteria have been promulgated by the EPA for many of the CoCs. Several of these criteria are calculated as a function of water hardness and a few are numerical standards. The numerical water quality standards are presented in Table 5-21 and apply to all surface waters in the Silver Creek Drainage Project area. Those criteria that are a function of hardness have been calculated for each project subarea and are presented in Table 5-22. The hardness and calculated acute criteria are dependent on the sample station and sample date.

**TABLE 5-21 NUMERIC WATER QUALITY CRITERIA**

| **Acute Criteria (ug/l)** | **Hg** | **Total CN** |
|---|---|---|
| All Project Subareas and Sample Stations | 1.7 | 22 |

The EPA has not finalized sediment quality criteria. Proposed sediment criteria for metals currently consist of the Effect Range - Low (ER-L) and Effect Range - Median (ER-M) values generated from the pool of national fresh water and marine sediment toxicity information (Long and Morgan, 1991). The ER-M values are probably most appropriate to use for comparison to Spring Creek sediment data, and are presented in Table 5-23.

#### 5.2.4.2 Deer Ingestion Scenario

Adverse effects data for test animals were obtained from the Agency for Toxic Substances and Disease Registry toxicological profiles (ATSDR, 1991a, 1991b, 1991c), and from other literature sources (NAS, 1980; Maita et al, 1981). The data consist of dose (intake) levels that either cause no adverse effects (NOAELs) and/or the lowest dose observed to cause an adverse effect (LOAELs) in laboratory animals. The use of effects data for alternative species introduces an uncertainty factor to the assessment, however, effects data are not available for the species of concern (deer), so the effects data for laboratory animals (primarily rats) are adjusted only for increased body weight. These data are listed in Table 5-24.

#### 5.2.4.3 Plant - Phytotoxicity Scenario

Information is available on the phytotoxicity for some of the CoCs (Kabata-Pendias and Pendias, 1989) and these are listed in Table 5-25. The availability of contaminants to plants and the potential for plant toxicity depends on many factors including soil pH, soil texture, nutrients, and plant species.

## TABLE 5-22 HARDNESS-DEPENDENT WATER QUALITY CRITERIA

| Contaminant of Concert | Drumlummon Millsite | | | Drumlummon Tailings | | | Goldsil Tailings | | | Upper, Middle and Lower Ponds | | | Silver Creek Placer Tailings | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Water Conc (ug/l) | Hardness (mg/l) | Acute Criteria (ug/l) | Water Conc (ug/l) | Hardness (mg/l) | Acute Criteria (ug/l) | Water Conc (ug/l) | Hardness (mg/l) | Acute Criteria (ug/l) | Water Conc (ug/l) | Hardness (mg/l) | Acute Criteria (ug/l) | Water Conc (ug/l) | Hardness (mg/l) | Acute Criteria (ug/l) |
| Cadmium | NC | | | NC | | | 4 | 201 | 4.3 | 1 | 85 | 1.8 | NC | | |
| Copper | NC | | | NC | | | 5 | 180 | 24.4 | 8 | 85 | 12.0 | NC | | |
| Lead | 9 | 130 | 114.0 | 5 | 158 | 146.2 | 3 | 201 | 198.6 | 1 | 85 | 66.4 | 1 | 85 | 66.4 |
| Silver | ND | | | ND | | | ND | | 0 | NC | | | NC | | |
| Zinc | NC | | | NC | | | 80 | 213 | 227.4 | 110 | 234 | 246.2 | NC | | |

NC - Not a contaminant of concern in this project subarea
ND - below laboratory detection limits

## TABLE 5-23 SEDIMENT QUALITY CRITERIA (PROPOSED)

| Criteria (mg/kg) | Cd | Cu | Pb | Zn |
|---|---|---|---|---|
| Effect Range - Median (ER-M) | 9 | 390 | 110 | 270 |

## TABLE 5-24 TOXICOLOGICAL EFFECTS LEVELS FOUND IN THE LITERATURE

| Dose (mg/Kg-day) | As | Cd | Cu | Pb | Zn |
|---|---|---|---|---|---|
| LOAEL - Rat | 6.4 | 0.014 | 90 | 0.005 | 571 |
| Reference: | ATSDR, 1991a, p30 | ATSDR, 1991b, p33 | NAS, 1980 | ATSDR, 1991c, p72 | Maita et al, 1981 |

Note: LOAEL = Lowest observed adverse effect level.

**TABLE 5-25 SUMMARY OF SOIL CONCENTRATIONS USED FOR PHYTOTOXICITY ASSESSMENT (mg/Kg)**

| Project Subarea | Ag | Cd | Cu | Hg | Pb | Zinc |
|---|---|---|---|---|---|---|
| Drumlummon Millsite | NS | NC | NC | NS | 173 | NC |
| Drumlummon tailings | NS | NC | NC | NS | 55 | NC |
| Goldsil tailings | NS | 3.1 | 165 | NS | 180.2 | 365.2 |
| Upper, Lower and Middle Ponds | NS | 2.4 | 127 | NS | 132 | 263.4 |
| Silver Creek Placer Tailings | NS | NC | NC | NS | 44 | NC |

NC - Not a contaminant of concern in this project subarea
NS - not calculated because no applicable standard exists

### 5.2.5 Risk Characterization

This section combines the ecologic exposure estimates and concentrations presented in Section 5.2.3 and the ecologic effects data presented in Section 5.2.4 to provide a screening level estimate of potential adverse ecologic impacts for the three scenarios evaluated. This was accomplished by generating ecologic impact quotients (EQs), analogous to the health HQs calculated for human exposures to noncarcinogens. CoC-specific EQs were generated by dividing the particular intake estimate or concentration by available ecological effect values or concentrations. As with HQs, if EQs are less than one, adverse ecologic impacts are not expected.

#### 5.2.5.1 Aquatic Life Surface Water Scenario

For this scenario, surface water concentration data are compared to acute aquatic life criteria. Limitations of this comparison are that the EPA water quality criteria are not species-specific toxicity levels. They represent toxicity to the most sensitive species, which may or may not be present in the Silver Creek Drainage Project area, and toxicity to the most sensitive species may not in itself be a limiting factor for the maintenance of a healthy, viable fishery and/or other aquatic organisms. The results of the EQ calculations for this scenario are presented in Table 5-26.

**TABLE 5-26 ECOLOGIC IMPACT QUOTIENTS FOR SURFACE WATER - ACUTE AQUATIC LIFE SCENARIO**

| Project Subarea | Ag | Cd | Cu | Hg | Pb | Zn |
|---|---|---|---|---|---|---|
| Drumlummon Millsite | ND | NC | NC | 0.1176 | 0.0789 | NC |
| Drumlummon tailings | ND | NC | NC | 0.2353 | 0.0342 | NC |
| Goldsil tailings | ND | 0.0258 | 0.1232 | 0.0588 | 0.0151 | 0.3518 |
| Upper, Lower and Middle Ponds | NC | 0.5530 | 0.6660 | 0.0588 | 0.0151 | 0.4467 |
| Silver Creek Placer Tailings | NC | NC | NC | 0.0588 | 0.0151 | NC |

NC - Not a contaminant of concern in this project subarea
ND - below laboratory detection limits

The EQ values for each element in each project subarea are all below one. Elements with EQ values greater than one have the potential for acute aquatic life impacts.

#### 5.2.5.2 Aquatic Life Sediment Scenario

Stream sediment concentration data are compared to proposed sediment quality criteria using a similar method as for calculating surface water impacts. Limitations of this comparison include that these sediment quality criteria are preliminary and are also not species-specific. They represent sediment toxicity to the most sensitive species, which may or may not be present in the Silver Creek Drainage Project area, and toxicity to the most sensitive species may not in itself be a limiting factor for the maintenance of a healthy, viable fishery and/or other aquatic organisms. The results of these EQ calculations are presented in Table 5-27. As shown in Table 5-27, there are no applicable sediment criteria for mercury. A review of the literature showed that the Oregon Department of Environmental Quality has a freshwater sediment screening level value for mercury of 0.2 mg/Kg. The screening level value is the exposure concentration deemed acceptable for ecological receptors. The Massachusetts Department of Environmental Protection has threshold effect concentrations for 28 chemicals, including mercury, for use in screening freshwater sediment for risk to benthic organisms. The threshold effect concentrations are intended to identify contaminant concentrations below which harmful effects on sediment-dwelling organisms are not expected. The threshold effect concentration for mercury is 0.18 mg/Kg. NOAA (Buchman, 1999) has developed screening quick reference tables (SQuiRTs) for both freshwater and marine sediment. The SQuiRTs data present screening levels for levels of potential effects to aquatic life from contaminated sediment. The threshold effects level (TEL) represents the concentration below which adverse effects are expected to occur only rarely, while the probable effects level (PEL) is the concentration above which adverse effects are frequently expected. Freshwater TEL and PEL values are based on benthic community metrics and toxicity test results. The TEL and PEL values for mercury are 0.174 and 0.486 mg/Kg, respectively. Thus, the Oregon, Massachusetts and NOAA sediment levels for mercury all point to a threshold value in the vicinity of 0.2 mg/Kg.

**TABLE 5-27 ECOLOGIC IMPACT QUOTIENTS (EQS) FOR THE SEDIMENT - AQUATIC LIFE SCENARIO**

| Project Subarea | Ag | Cd | Cu | Hg | Pb | Zn |
|---|---|---|---|---|---|---|
| Drumlummon Millsite | NA/NS | NC | NC | NS | 0.6909 | NC |
| Drumlummon tailings | NA/NS | NC | NC | NS | 0.3818 | NC |
| Goldsil tailings | NA/NS | 0.0556 | 0.4205 | NS | 1.4000 | 0.7963 |
| Upper, Lower and Middle Ponds | NA/NS | 0.0556 | 0.1487 | NS | 0.3545 | 0.3148 |
| Silver Creek Placer Tailings | NA/NS | NC | NC | NS | 0.5636 | NC |

NA - not analyzed
NC - not a contaminant of concern in this project subarea
ND - below laboratory detection limits
NS - not calculated because no applicable standard exists

The EQs presented in Table 5-27 indicate the potential for aquatic life impacts (EQs greater than 1) due to apparent sediment toxicity for lead in Silver Creek near the Goldsil tailings. Based on a mercury threshold value for sediment of 0.2 mg/Kg, EQ values for mercury in the five Silver Creek Drainage Project Phase I and II subareas would range from 30 to 150. At the SQuiRTs PEL for mercury of 0.486 mg/Kg, the EQ values for mercury would range from about 12 to 62. The elevated EQ for lead and mercury suggest that there is a potential to adversely affect sediment benthos, fish embryos, and/or macroinvertebrate communities. However, the sediment criteria used to calculate these EQs may not apply to species found in this system. Previous studies completed by the MDFWP (MDFWP and MDHES, 1994 and MDFWP, 1984) have shown elevated levels of mercury in the tissue of fish in Silver Creek. Silver Creek is posted by MDFWP as catch and release only because of elevated mercury concentrations in fish tissue. The Phase I site characterization showed that lead and mercury concentrations are the highest in the vicinity of the Goldsil tailings and just downstream from the Silver Creek placer tailings.

#### 5.2.5.3 Deer Ingestion Scenario

Estimated deer ingestion doses were compared to the higher of the literature derived toxicological effect level (the LOAEL) and CoC-specific EQs were generated by dividing the intake estimates by the toxicological effect value. Again, the comparison is limited because of the use of effects data for alternate species, adjusted only for increased body weight and the species used for the toxicology studies may be more or less susceptible to the contaminant being studied than deer. The results of the EQ calculations for this scenario are presented in Table 5-28.

**TABLE 5-28 ECOLOGIC IMPACT QUOTIENTS (EQS) FOR THE DEER INGESTION SCENARIO - LOAEL**

| Project Subarea | Ag | Cd | Cu | Hg | Pb | Zn |
|---|---|---|---|---|---|---|
| Drumlummon Millsite | NS | NC | NC | NS | 0.8149 | NC |
| Drumlummon tailings | NS | NC | NC | NS | 0.3220 | NC |
| Goldsil tailings | NS | 0.0046 | 0.00003 | NS | 0.6613 | 0.00003 |
| Upper, Lower and Middle Ponds | NC/NS | 0.0132 | 0.00004 | NS | 0.4492 | 0.00004 |
| Silver Creek Placer Tailings | NC/NS | NC | NC | NS | 0.1693 | NC |

Note: LOAEL = Lowest observed adverse effect level.
NC - not a contaminant of concern in this project subarea
NS - not calculated because no applicable standard exists

The EQ data presented in Table 5-28 do not indicate the potential for adverse ecologic impacts (EQ greater than 1) to deer due to uptake of metals from the waste salts in the tailings in any of the project subareas or from water in Silver Creek. The assumptions used to derive the uptake dose and the comparison to rat toxicity, may overestimate the actual average contaminant intake, but likely by less than an order of magnitude. It should be noted that there are no applicable standards for mercury.

#### 5.2.5.4 Plant - Phytotoxicity Scenario

Source area average concentrations collected in the Silver Creek Drainage Project area are compared to high values of the range of plant phytotoxicity derived from the literature. Limitations of this comparison include that the phytotoxicity ranges are not species-specific and they represent toxicity to species which may or may not be present in the Silver Creek Drainage Project area. Additionally, other physical characteristics of the waste materials may create microenvironments which limit growth and survival of terrestrial plants directly or in combination with substrate toxicity. Waste materials are likely to have poor water holding capacity, low organic content, limited nutrient, and may harden enough to resist root penetration. The results of the EQ calculations for this scenario are presented in Table 5-29.

**TABLE 5-29 ECOLOGIC IMPACT QUOTIENTS (EQS) FOR THE PLANT - PHYTOTOXICITY SCENARIO**

| Project Subarea | Ag | Cd | Cu | Hg | Pb | Zn |
|---|---|---|---|---|---|---|
| Drumlummon Millsite | NS | NC | NC | NS | 0.4325 | NC |
| Drumlummon tailings | NS | NC | NC | NS | 0.1375 | NC |
| Goldsil tailings | NS | 0.3875 | 1.3200 | NS | 0.4505 | 0.9130 |
| Upper, Lower and Middle Ponds | NC/NS | 0.3000 | 1.0160 | NS | 0.3300 | 0.6585 |
| Silver Creek Placer Tailings | NC/NS | NC | NC | NS | 0.1100 | NC |

NC - not a contaminant of concern in this project subarea
NS - not calculated because no applicable standard exists

The EQs presented in Table 5-29 indicate the potential for adverse ecologic impacts to plant communities from copper at the Goldsil tailings and the Upper, Middle and Lower Ponds. The non-conservative assumption of using the high end of the phytotoxicity range to derive the EQs probably underestimates the potential phytotoxic effect to the plant community.

### 5.2.6 Risk Characterization Summary

The calculated EQs can be used to assess whether ecologic receptors are exposed to potentially harmful doses of site-related contaminants via the four ecologic scenarios evaluated. The EQs for each of the four scenarios are presented in Table 5-30 to estimate a combined ecologic EQ for each scenario and each contaminant. The EQ values in the table are the maximum value for the respective scenario or CoC. The results of combining the ecologic scenarios are also summarized in Table 5-30.

The EQs shown in Table 5-30 indicate that the contaminants at the site constitute probable adverse ecologic effects via the surface water, sediment and plant phytotoxicity exposure scenarios. The totals by CoC for copper, lead and zinc retained EQ values greater than one in one or more of the project subareas. The two other CoCs, mercury and silver, did not exceed EQ values greater than one, however, no applicable standards exist for mercury or silver for evaluation of sediment, deer ingestion or plant phytotoxicity exposure scenarios. Therefore, the total EQ values for mercury and silver will be underestimated.

Specific exposure scenarios that exceed an EQ value of one include:

- sediment and plant phytotoxicity at the Goldsil tailings; and
- surface water and plant phytotoxicity at the Upper, Middle and Lower Ponds.

Specific CoCs that exceed an EQ value of one include:

- copper, lead and zinc at the Goldsil tailings;
- copper, lead and zinc at the Upper, Middle and Lower Ponds; and
- lead at the Drumlummon millsite.

Total EQ values exceed one for the Drumlummon millsite, Drumlummon tailings, Goldsil tailings, and the Upper, Middle and Lower Ponds.

**Table 5-30 Summary of Combined Ecologic Impact Quotients for the Silver Creek Drainage Project**

| | Surface Water | Sediment | Deer Ingestion | Plant Phytotoxicity | Total by CoC |
|---|---|---|---|---|---|
| **Drumlummon Millsite** | | | | | |
| Cadmium | NC | NC | NC | NC | -- |
| Copper | NC | NC | NC | NC | -- |
| Lead | 0.0789 | 0.6909 | 0.8149 | 0.4325 | 2.0173 |
| Mercury | 0.1176 | NS | NS | NS | 0.1176 |
| Silver | ND | NA/NS | NS | NS | -- |
| Zinc | NC | NC | NC | NC | -- |
| TOTAL | 0.1966 | 0.6909 | 0.8149 | 0.4325 | 2.1349 |
| **Drumlummon Tailings** | | | | | |
| Cadmium | NC | NC | NC | NC | -- |
| Copper | NC | NC | NC | NC | -- |
| Lead | 0.0342 | 0.3818 | 0.322 | 0.1375 | 0.8755 |
| Mercury | 0.2353 | NS | NS | NS | 0.2353 |
| Silver | ND | NA/NS | NS | NS | -- |
| Zinc | NC | NC | NC | NC | -- |
| TOTAL | 0.2695 | 0.3818 | 0.3220 | 0.1375 | 1.1108 |
| **Goldsil Tailings** | | | | | |
| Cadmium | 0.0258 | 0.0556 | 0.00457 | 0.3875 | 0.4734 |
| Copper | 0.1232 | 0.4205 | 0.00003 | 1.3200 | 1.8637 |
| Lead | 0.0151 | 1.4 | 0.66130 | 0.4505 | 2.5269 |
| Mercury | 0.0588 | NS | NS | NS | 0.0588 |
| Silver | ND | NA/NS | NS | NS | -- |
| Zinc | 0.3518 | 0.7963 | 0.00003 | 0.9130 | 2.0612 |
| TOTAL | 0.5747 | 2.6724 | 0.6659 | 3.071 | 6.9840 |
| **Upper, Middle, Lower Ponds** | | | | | |
| Cadmium | 0.0553 | 0.0556 | 0.00378 | 0.3000 | 0.4146 |
| Copper | 0.6660 | 0.1487 | 0.00004 | 1.0160 | 1.8308 |
| Lead | 0.0015 | 0.3545 | 0.42270 | 0.3300 | 1.1088 |
| Mercury | 0.0588 | NS | NS | NS | 0.0588 |
| Silver | NC | NA/NS | NC/NS | NC/NS | -- |
| Zinc | 0.4467 | 0.3148 | 0.00004 | 0.6585 | 1.4201 |
| TOTAL | 1.2419 | 0.8736 | 0.4530 | 2.3045 | 4.8731 |
| **Silver Creek Placer Tailings** | | | | | |
| Cadmium | NC | NC | NC | NC | -- |
| Copper | NC | NC | NC | NC | -- |
| Lead | 0.0151 | 0.5636 | 0.1693 | 0.11 | 0.8580 |
| Mercury | 0.0588 | NS | NS | NS | 0.0588 |
| Silver | NC | NA/NS | NC/NS | NC/NS | -- |
| Zinc | NC | NC | NC | NC | -- |
| TOTAL | 0.0739 | 0.5636 | 0.1693 | 0.11 | 0.9169 |

NA - not analyzed
NC - not a contaminant of concern in this project subarea
ND - below laboratory detection limits
NS - not calculated because no applicable standard exists

# 6.0 RECLAMATION OBJECTIVES AND GOALS

The primary objective of reclamation in the Silver Creek Drainage Project area is to protect human health and the environment in accordance with the guidelines set forth by the NCP. Specifically, the remedy selected must limit human and environmental exposure to the CoCs and reduce the mobility of those contaminants to reduce impacts to the local water resources.

## 6.1 ARAR-BASED RECLAMATION GOALS

### 6.1.1 Groundwater

The groundwater resources in the vicinity of the tailings piles associated with Phases I and II of the Silver Creek Drainage Project are not currently used for a drinking water source, however, a potential future use of groundwater resources is for drinking water. Dissolved metal concentrations in the shallow alluvial aquifer in the proposed Goldsil repository area (Figure 3-20) do not exceed Montana HHS. However, total recoverable metals concentrations indicate potential impacts to the shallow alluvial aquifer from suspended sediment. Therefore, the potential for groundwater impacts is considered applicable to the site. The potential contaminants of concern at the site include: antimony, cadmium, copper, cyanide, lead, mercury, silver and zinc.

ARAR-based reclamation goals are most often the maximum contaminant levels (MCLs), non-zero maximum contaminant level goals (MCLGs), or state drinking water standards, whichever are more stringent. Potential ARAR-based reclamation goals for the CoCs in the groundwater medium are presented in Table 6-1. Although groundwater is not being considered for remediation at this site, removing source material may affect groundwater metal concentrations.

**TABLE 6-1 ARAR-BASED RECLAMATION GOALS FOR GROUNDWATER**

| Chemical | Type | Concentration, ug/L |
|---|---|---|
| Antimony | MCL | 6 |
| Cadmium | MCL | 5 |
| Copper | PP | 1300 |
| Total Cyanide | MCL | 200 |
| Lead | PP | 15 |
| Mercury | MCL | 2 |
| Silver | HA | 100 |
| Zinc | HA | 2000 |

HA - Health Advisory from EPA's "Drinking Water Standards and Health Advisories (EPA, 1993)
HHS - Human Health Standards for Surface Water (DEQ, 2002)
MCL - Maximum Contaminant Level Drinking Water Regulations and Health Advisories (EPA, 1993)
PP - Priority Pollutant Criteria

### 6.1.2 Surface Water

The results of the 1996 water quality investigation of the Silver Creek drainage basin by Maxim (DEQ-AMRB/Maxim, 1996) indicates that surface water resources near the site have been impacted by mine/mill wastes. Ore processing, which introduced mercury, infiltration of water, and erosion of tailings piles are considered primary processes which have contributed to the elevated metals observed in Silver Creek. Reclamation of the site should address the exposure risks inherent with the waste sources and provide controls which will protect water resources downstream of this area. Thus, surface water quality standards are applicable to the site.

Aquatic Life Standards and Human Health Standards are common ARARs for the surface water medium. The more stringent of the two standards is identified as the ARAR-based reclamation goal. The potential contaminants of concern at the site are: cadmium, copper, cyanide, lead, mercury, silver and zinc. The ARAR-based reclamation goals for surface water are presented in Table 6-2.

**TABLE 6-2 ARAR-BASED RECLAMATION GOALS FOR SURFACE WATER**

| Chemical | Type | Concentration, ug/L |
|---|---|---|
| Cadmium | CALS | 0.27 @ 100 mg/L hardness |
| Copper | CALS | 9.3 @ 100 mg/L hardness |
| Cyanide | CALS | 5.2 |
| Lead | CALS | 3.2 @ 100 mg/L hardness |
| Mercury | HHS | 0.05 |
| Silver | AALS* | 4.1* @ 100 mg/L hardness |
| Zinc | CALS | 119.8 @ 100 mg/L hardness |

* There is no chronic aquatic life standard for silver, so the acute aquatic life standard, which is more stringent than the human health standard, is presented.
HHS - Human Health Standards for Surface Water (DEQ, 2002)
AALS - Freshwater Acute Aquatic Life Standards (DEQ, 2002)
CALS - Freshwater Chronic Aquatic Life Standards (DEQ, 2002)

### 6.1.3 Soil

Chemical-specific ARARs are not available at this time for the soil medium.

## 6.2 RISK-BASED CLEANUP GOALS

Risk-based cleanup goals have been calculated for both the carcinogenic and noncarcinogenic estimates of human health risk in the Silver Creek Drainage Project area. Risk-based cleanup goals are only presented for the CoCs for which the recreational risk assessment indicated an exceedance of the hazard quotient for noncarcinogens greater than one or an exceedance of the carcinogenic risk value greater than 1E-06, and the exposure pathway was considered complete. The concentrations were derived using the risk-based cleanup guidelines for abandoned mine sites developed by the DEQ-MWCB (Tetra Tech, 1996) and applying the exposure assumptions presented in Section 5.1.2. The risk-based goals for soil and water represent the lowest concentration for each CoC determined from the various exposure pathways considered and are presented in Table 6-3. The proposed cleanup goals attempt to reduce the risk of excess incidence of cancer to 1.0E-06 (EPA, 1990) and the noncarcinogenic health hazard quotient (HQ) to 1 (EPA, 1989a).

**TABLE 6-3 RISK-BASED CLEANUP GOALS FOR SILVER CREEK DRAINAGE PROJECT PHASE I AND PHASE II AREAS ASSUMING MAXIMUM RECREATIONAL USE**

| Noncarcinogenic CoCs | Soil, mg/Kg | Water, ug/l |
|---|---|---|
| Antimony | 586[a] | 204[b] |
| Cadmium | 1,750[a] | 66.5[c] |
| Copper | 54,200[a] | 996[c] |
| Total Cyanide | 11,100[a] | 10,200[b] |
| Lead | 2,200[a] | 165[c] |
| Mercury | 440[a] | 0.294[c] |
| Silver | NA | NA |
| Zinc | 440,000[a] | 34,400[c] |
| **Carcinogenic CoCs** | | |
| Cadmium | NA | NA |

NA - No cleanup goal established
[a]Based on rockhound/gold panner soil ingestion/inhalation
[b]Based on rockhound/gold panner water ingestion
[c]Based on fish ingestion

## 7.0 DEVELOPMENT AND SCREENING OF RECLAMATION ALTERNATIVES

To facilitate the evaluation of potentially applicable reclamation technologies, the solid media at the site can be divided into four general categories based on physical and/or chemical characteristics. These categories include:

- mill tailings;
- waste rock piles;
- placer tailings;
- mine, millsite and tailings debris.

Treatment of the solid media is dependent on the concentration of metal contaminants in the media, as well as the physical characteristics of the media. The potential applicability of a technology is dependent on the interrelationship of reclamation technologies and the volume of material requiring treatment. A brief definition of each solid media category follows.

Mill Tailings - Mill tailings are generated from the milling and beneficiation of mined ore. Mill tailings are generally composed of fine to very fine-grained sand, silt and clay. Exposed mill tailings containing sulfide minerals, especially pyrite, may develop acid rock drainage (ARD). ARD is generated by the oxidation of sulfide minerals. This process may produce acid pH conditions and increased metal solubility. Mill tailings piles which have developed ARD conditions become source areas for metal, sulfate and total dissolved solids. These potential contaminants may be mobilized during precipitation (infiltration) and stormwater runoff. Mill tailings are located at the Drumlummon millsite, Drumlummon tailings area, Goldsil tailings area, and at the Upper, Middle and Lower Ponds.

Waste Rock Piles - Waste rock piles consist of overburden, altered and/or unaltered wallrock/country rock, and below economic grade ore materials. The piles are generally located within a minimal haulage distance from the mine and contain non-mineralized and low-grade mineralized rock extracted from the mine. Waste rock piles generally contain run-of-mine muck and consist of poorly sorted rock materials ranging in size from boulders down to clay-size fractions. The nature and extent of the mineralization, climatic conditions, and natural buffering capacity of the rock pile and underlying soils determine the potential of the waste rock to generate ARD and impact water quality. Waste rock piles were encountered in two areas during Phases I and II of the Silver Creek Drainage Project: 1) two small waste rock piles near the Drumlummon Mine area, and 2) two waste rock piles (one small and one large) located at the Drumlummon millsite.

Placer Tailings - Placer tailings are generated during the mining of unconsolidated alluvium contained within the surface water body or its floodplain. The stream channel and floodplain alluvium may contain economic concentrations of certain metals, i.e. gold and silver, which are won by removing the sand and gravel and processing it by gravity and amalgamation (use of mercury to extract precious metals) methods. Although it is dependent on the scale of the amalgamation process, mercury is generally not a problem in smaller scale placer tailings. If not reclaimed, placer tailings act as a of source for silt which can impact water quality during periods of heavy stormwater runoff. Placer tailings are contained throughout much of the Silver Creek Drainage Project area, but most are concentrated in the area between the Goldsil millsite and Birdseye Road. The placer tailings located above the Goldsil millsite are from early placer operations and are generally small in volume compared to those farther downstream. The volume of placer tailings increases significantly below the Goldsil millsite probably due to the use of mechanized placer methods employing dredges.

Mine, Millsite and Tailings Debris - There are a number of old structures and debris and solid waste areas located within the Silver Creek Drainage Project. Some of these items may have historical significance. In the Drumlummon mine area, there are several wooden structures, including cabins and an old hoist house, and an old metal boiler. At the Drumlummon mill area, there is wood and metal debris and rail tracks and ties on the waste rock piles. The Drumlummon tailings area has wood cribbing and steel cable debris associated with the dam. The Goldsil tailings have scattered wood debris on the west end, and the liner in and around the lined pond area. Southwest of the lined pond is the core shack, an old wooden building that contains drill cores and sample bags of drill cuttings. The largest concentration of debris is in the Goldsil millsite area. This includes two boneyard/debris areas located at the southeast corner of the lined pond and west of the ramp tailings area, and a solid waste pit located north of the former Goldsil mill. These areas contain cyanide drums that appear to be empty but may contain residual chemical, some batteries, metal beams, metal siding, insulation, tires and miscellaneous solid waste. The former Goldsil mill area contains concrete slabs and foundations, a ball mill, a large concrete retaining wall, metal vat tank bottoms, steel cable, electric cable and wood crib walls. The Upper Pond area contains an old metal decant tower, old wood piping and a metal tailings distribution box. A dilapidated old camping trailer is located directly south of the Upper Pond. An old tailings discharge line constructed of wooden pipe runs along the north perimeter of the Middle and Lower Pond areas. The tailings line is still partially filled with mill tailings. There is also scattered wood debris which appears to be remnants of a wooden trestle for the tailings line in this area. The Lower Pond area also contains a wooden headframe, a metal tailings distribution tank, rubber hose and plastic piping that were used for tailings distribution and an electrical box and power pole. Another debris area is the vat tank area located east of the main placer tailings piles and west of Birdseye Road. The vat tank area includes three empty metal vat tanks, two wooden vat tanks with collapsed wooden beams over them, other wood debris, metal piping and an old car body. To eliminate safety concerns, some wooden structures, wood piping and other debris features may have to be removed during the reclamation activities if they are determined to be historically insignificant in the historic and cultural resources study.

## 7.1 IDENTIFICATION AND SCREENING OF RECLAMATION TECHNOLOGIES AND PROCESS OPTIONS

The purpose of identifying and screening technology types and processes is to eliminate those technologies and process options that are unfeasible. General response actions are refined into technology types and process options. The technology and process options are screened for reclaiming solid mine/mill waste consisting of mill tailings, waste rock, placer tailings and impacted soils in the Phases I and II areas of the Silver Creek Drainage Project. Although many remedial treatment technologies and process options have been evaluated by other workers for mine/mill solid waste, most of these are not considered feasible. These technologies involve a variety of techniques related to physical/chemical and thermal treatment processes. At the present time, most of these technologies would require extensive treatability studies, are cost prohibitive and thus not considered appropriate. Therefore, the screening process has only evaluated a limited number of treatment technologies. Table 7-1 summarizes the results of the screening process for developing reclamation alternatives for the Phases I and II of the Silver Creek Drainage Project. The following discussion summarizes each of the reclamation technologies and process options identified.

## TABLE 7-1 RECLAMATION TECHNOLOGY SCREENING SUMMARY

| General Response Actions | Remedial Technology | Process Option | Description | Screening Comment |
|---|---|---|---|---|
| **No Action** | None | Not Applicable | No Action | |
| **Institutional Controls** | Access Restrictions | Fencing | Security fences installed around contaminated areas to limit access | |
| | | Land Use Controls | Legal restrictions to control current and future land use | Potentially effective in conjunction with other technologies; Readily implementable |
| **Engineering Controls** | Containment | Wet Closure | Construct dam & flood tailings with water to limit oxidation/migration of contaminants by establishing anaerobic environment | Potentially effective if tailings consolidated and adequate water maintained during dry season; Implementable |
| | | Soil Cover | Apply soil and establish vegetation to cover contaminant source | Surface infiltration would be reduced by evapotranspiration, but not prevented; Readily implementable |
| | | Multi-layered RCRA Cap | Compacted clay layer covered with soil & vegetation in contaminated surface areas | Potentially effective for waste source surface isolation; surface infiltration would be significantly reduced; Readily implementable |
| | | Asphalt or Concrete Cover | Apply asphalt or concrete over areas of exposed tailings and ore/waste rock | Limited feasibility due to cracking over long term |
| | Surface Controls | Consolidation | Combining tailings, waste rock and impacted soil into single area | Potentially effective if combined with other process options; involves moving solid mine waste to single area; Readily implementable |
| | | Grading | Level waste piles to reduce slopes for managing runoff, erosion & surface infiltration | Potentially effective if combined with other process options; Readily implementable |
| | | Revegetation | Add amendments to waste & seed to promote vegetation for controlling water infiltration & erosion | Potentially effective in arid climates if waste does not contain high concentrations of phytotoxic elements; Readily implementable |

## TABLE 7-1 RECLAMATION TECHNOLOGY SCREENING SUMMARY (CONTINUED)

| General Response Actions | Remedial Technology | Process Option | Description | Screening Comment |
|---|---|---|---|---|
| **Engineering Controls (continued)** | | Erosion Protection/ Runon Control | Erosion resistant materials, commercial fabrics placed on tailings; stormwater diversion structures to channel water away from tailings and waste rock | Potentially effective at reducing lateral contaminant migration; Readily implementable |
| | On-site Disposal | RCRA Landfill | Excavated solid mine/mill waste deposited on-site in RCRA landfill | Potentially effective; Readily implementable |
| | | Solid Waste Landfill | Excavated tailings & waste rock deposited in solid waste landfill | Potentially effective for non-hazardous materials or residues from other treatment options; Readily implementable. |
| | Off-site Disposal | Permitted Tailings Impoundment | Depositing tailings in permitted tailings facility | Potentially effective if facility can accept off-site tailings and is willing to do so |
| | | RCRA Landfill | Tailings & waste rock disposed of in RCRA-C permitted facility | Potentially effective; Readily implementable |
| | | Solid Waste Landfill | Non-hazardous mill solid wastes disposed of in non-RCRA C facility | Potentially effective for non-hazardous materials or residue from other treatment options; Readily implementable, but administratively questionable |
| **Excavation and Treatment** | Reprocessing | Milling and Smelting | Shipping tailings and waste rock to operating mill and/or smelter facility for extraction of metals | Potentially effective if economic concentrations of metals are present in wastes and an operating facility can accept off-site materials for processing and is willing to do so |
| | Fixation/ Stabilization | Cement/ Pozzolan Additive | Tailings and waste rock are solidified with non-leachable cement or pozzolan | Extensive treatability testing and proper disposal of stabilized material would be required; Potentially implementable but cost prohibitive |
| **In-Situ Treatment** | Physical/Chemical Treatment | Stabilization | Tailings and waste rock treated in place when injected with stabilizing agent(s) | Extensive treatability testing required; Potentially implementable, but cost prohibitive |

### 7.1.1 No Action

The no action option would require no further reclamation or monitoring actions at the site. The no action response is generally used as a baseline against which other reclamation options can be compared.

### 7.1.2 Institutional Controls

Land use and access restrictions are potentially applicable institutional controls for the site. Land use restrictions would limit the possible future uses of the land by employing deed restrictions in the event of property sale. Access restrictions commonly utilize fencing to control access to the site area. Land use and access restrictions may be applicable in the case of no action, capping in place, on-site disposal or any option that would leave contaminated materials on site. Such restrictions would aid in controlling future activities that may compromise a reclamation action. Institutional controls involving access restrictions via fencing and/or land use controls do not achieve a clean-up goal but are considered options which may compliment other reclamation processes.

### 7.1.3 Engineering Controls

Engineering controls are used to reduce the mobility of contaminants by establishing barriers that prevent contaminant exposure and migration. Engineering controls typically include containment, capping, runon/runoff controls, revegetation and/or disposal. Engineering controls generally do not reduce the volume or toxicity of the hazardous materials.

#### 7.1.3.1 Containment

Containment technologies are used as source control measures. They are designed to eliminate direct contact and fugitive emissions from the contaminated materials. In addition, such controls are used to divert and minimize infiltration of surface water/precipitation that may contribute to erosion and/or leachate formation. The cap or cover design is a function of the degree of hazard posed by the contaminated media and may vary from a simple soil cover to a multi-layered RCRA hazardous waste cap. Specific RCRA landfill closure design criteria are put forth in 40 CFR 264.310. RCRA-designed caps may not be appropriate in instances where there is low precipitation, the toxicity of the contaminated source is relatively low, the cap is considered temporary or the waste material is not leached by infiltrating water. Future land use upon closure may also influence cap design.

Capping is an appropriate alternative when contaminated materials are to be left on site. The on-site capping option implementation is dependent on the relative toxicity of the contaminants and demonstrated impacts to human health and/or environment. Capping is also an option when excavation and disposal or treatment actions are cost prohibitive. Capping of mine/mill wastes is considered to be a standard construction practice employing accepted design methods and available equipment.

#### 7.1.3.2 Surface Controls

Surface controls are used to minimize contaminant migration. Surface controls alone may not be appropriate in areas where direct human contact is a primary concern. In these instances, surface controls are commonly integrated with containment to provide further protection. Surface control process options are directed at controlling water and wind impacts on contaminated materials. These options include consolidation, grading, revegetation, and erosion controls.

Consolidation involves grouping wastes of similar type in a common area for more efficient management or treatment. Consolidation is important in areas where multiple smaller waste sources are present and wastes are in sensitive areas (i.e. residential or floodplain). Grading is used to reshape and compact waste areas in order to reduce slopes, manage the runon/runoff and infiltration of surface water and control erosion. Depending on the site conditions, periodic maintenance may be necessary to control subsidence and erosion problems after closure.

Revegetation involves adding soil amendments to a limited depth in the waste in order to provide nutrients and organic materials to establish vegetation. In addition, neutralizing agents and/or additives to improve pH conditions and/or the water storage capacity of the waste may be appropriate. Revegetation is essential to controlling water and wind erosion processes and minimizing infiltration of water through plant evapotranspiration processes. Revegetation generally involves the selection of appropriate plant species, preparation of the seeding area, seeding and/or planting, mulching and/or chemical stabilization and finally fertilization. Depending on the success of revegetation, the site may require maintenance in order to establish a self-sustaining plant community.

Erosion protection includes using erosion resistant materials to control water and wind impact on the contaminated media surface. Processes include surface water diversions, application of mulch and natural or synthetic fabric mats, and riprap. The erosion resistant materials are strategically placed based on a knowledge of the drainage area characteristics, slopes, vegetation types and densities, soil texture, and precipitation data.

#### 7.3.1.3 On-Site Disposal

On-site disposal can be used as a permanent source control measure. On-site disposal may require solid waste or hazardous waste repository design or a modification of these designs. The design of the containment facility would depend on the toxicity and type of material requiring disposal. This remedial technology involves placing the untreated or treated contaminated materials in an engineered repository located in the area of the site. Design specifications could range from a simple, unlined and covered impoundment to a double-lined and double-leachate collection system repository employing a RCRA-type cap. Contaminated media failing to meet Toxicity Characteristic Leaching Procedure (TCLP) criteria may require disposal in RCRA hazardous waste-type repository and could be subject to RCRA landfill closure performance standards. Solid wastes from the beneficiation of ores and minerals, however, are not considered hazardous wastes under RCRA regulations (CFR 261.4 (b) (7)).

#### 7.1.3.4 Off-Site Disposal

Off-site disposal involves excavating the contaminated materials and transporting them to an existing engineered repository permitted to accept such materials. Off-site disposal options may be applied to untreated or pre-treated contaminated media and would depend on the TCLP results for representative samples. Materials failing to meet TCLP criteria would require disposal in a RCRA-permitted facility. Less toxic materials could possibly be disposed of in a permitted solid waste or sanitary landfill. Solid wastes from the beneficiation of ores and minerals, however, are not considered hazardous wastes under RCRA regulations (CFR 261.4 (b) (7)).

Disposal of tailings and ore/waste rock materials in an existing permitted tailings or waste rock impoundment is considered not feasible because operating permits do not allow acceptance of off-site generated waste materials for disposal and, furthermore, mine/mill environmental managers have indicated that the environmental liability risk is not worth the endeavor. Likewise, potentially responsible parties do not want to undertake additional environmental liability by placing their waste materials at an operating mine facility that may be subject to future environmental liability.

### 7.1.4 Excavation and Treatment

Excavation and treatment processes involve the removal of the contaminated materials and subsequent treatment of them to reduce toxicity and/or volume. Treatment processes may involve a variety of techniques including chemical, physical or thermal methods. These methods are used to concentrate metal contaminants for additional treatment or recovery of economic constituents or to reduce the toxicity of hazardous constituents.

#### 7.1.4.1 Reprocessing

Reprocessing involves excavation and transportation of contaminated materials to an existing mill or smelter for processing and recovery of valuable metals. Applicability of this option is dependent on the concentration of economically viable elements and the ability and willingness of the facility to process the material and dispose of the waste. Reprocessing of mine/mill wastes from outside sources is not commonly practiced due to the low concentrations of metals in source materials, operating permits limiting processing of off-site materials, and Superfund liability.

#### 7.1.4.2 Fixation/Stabilization

Fixation/stabilization technologies employ treatment processes which chemically alter the contaminant to reduce its mobility or toxicity (fixation) or physically treat the contaminant by encapsulating with an inert material (stabilization). The technology involves mixing materials with binding agents under specific conditions to form a stable matrix. For inorganic contaminants, fixation/stabilization employs a reagent or combination of reagents to promote a chemical and/or physical change in order to reduce the mobility. Treatment processes commonly use lime, fly ash, or pozzolan/cement as additives.

### 7.1.5 In-Situ Treatment - Stabilization

In-situ treatment involves treating the contaminated materials in place with the objective of reducing mobility and toxicity of problem constituents. In-situ treatments provide less control than excavation and treatment options because they afford less efficient mixing of the additives. In-situ physical/chemical treatment technologies include stabilization, solidification and soil flushing. For the purpose of Phases I and II of the Silver Creek Drainage Project, only stabilization is discussed as a potential option. Stabilization has been used at some mining-related sites as a supporting reclamation technique. The process is similar to conventional stabilization in that one or more stabilizing agents are applied to the contaminated media by deep mixing techniques. At tailings sites, for example, some workers have used plowing tools which have been modified and are towed by dozers to achieve deeper mixing depths than afforded by conventional farm equipment.

## 7.2 IDENTIFICATION AND EVALUATION OF ALTERNATIVES

The purpose of the initial screening of alternatives is to identify those alternatives appropriate for a subsequent, detailed analysis. The initial screening also helps identify technology type, process options and specific data needs for detailed site characterization.

This section identifies potential reclamation alternatives from the reclamation technology types and associated process options that passed the initial screening effort presented in Section 7.1. Table 7-2 presents the preliminary reclamation alternatives for Phases I and II of the Silver Creek Drainage Project. These retained alternatives are further screened in this section on the basis of effectiveness, implementability, and relative costs. The objective of the preliminary screening is to better define the number of reclamation alternatives that will require detailed evaluation.

Reclamation alternatives are generally screened on the basis of effectiveness, implementability, and cost. The evaluation of effectiveness includes determining the ability of an alternative to manage the contaminated media sufficiently to achieve the reclamation goals and mitigate potential future exposure. The reclamation goals include overall protection of human health and the environment, compliance with ARARs, and short- and long-term effectiveness and/or performance related to reducing toxicity, mobility, and/or volume of contaminants. The effectiveness screening criteria considers the nature and extent of contamination and site-specific conditions such as geology, hydrology, climate and land use.

The implementability of each alternative is evaluated in light of the technical and administrative feasibility of constructing, operating and maintaining the reclamation alternative. Technical feasibility considerations include the applicability of the alternative to the waste source, availability of the required equipment and expertise to implement the alternative, and overall reliability of the alternative. Implementability also considers appropriate combinations of alternatives based on site-specific conditions. Administrative feasibility evaluates logistical and scheduling constraints.

Cost screening consists of developing conservative, order-of magnitude cost estimates for each reclamation alternative based on similar sets of assumptions (i.e., volume estimates). Unit costs are based on assessments of materials handling and procurement, site conditions, administrative and engineering costs, and contingency and are based on present worth values.

Total costs were derived by applying estimated unit costs to assumed volumes of material to be handled or quantity of work to be performed.

**TABLE 7-2. RECLAMATION ALTERNATIVES FOR PHASES I AND II OF THE SILVER CREEK DRAINAGE PROJECT**

| | |
|---|---|
| Alternative 1: | No Action |
| Alternative 2: | Institutional Controls |
| Alternative 3: | Consolidation/In-Place Containment of Tailings |
| Alternative 4: | In-Place Containment of Waste Rock |
| Alternative 5: | Partial On-Site Disposal of Tailings in the Goldsil Area Repository |
| Alternative 5a: | Partial On-Site Disposal of Tailings in a Constructed RCRA Subtitle C Repository in the Goldsil Area |
| Alternative 5b: | Partial On-Site Disposal of Tailings in a Constructed Modified RCRA Repository in the Goldsil Area |
| Alternative 5c: | Partial On-Site Disposal of Tailings in a Constructed Unlined Repository with a Multi-Layered Cap in the Goldsil Area |
| Alternative 6: | Partial On-Site Disposal of Tailings in the Lower Pond Area Repository |
| Alternative 6a: | Partial On-Site Disposal of Tailings in a Constructed RCRA Subtitle C Repository in the Lower Pond Area |
| Alternative 6b: | Partial On-Site Disposal of Tailings in a Constructed Modified RCRA Repository in the Lower Pond Area |
| Alternative 6c: | Partial On-Site Disposal of Tailings in a Constructed Unlined Repository with a Multi-Layered Cap in the Lower Pond Area |
| Alternative 7: | On-Site Disposal of Tailings in the Goldsil Area Repository |
| Alternative 7a: | On-Site Disposal of Tailings in a Constructed RCRA Subtitle C Repository in the Goldsil Area |
| Alternative 7b: | On-Site Disposal of Tailings in a Constructed Modified RCRA Repository in the Goldsil Area |
| Alternative 7c: | On-Site Disposal of Tailings in a Constructed Unlined Repository with a Multi-Layered Cap in the Goldsil Area |
| Alternative 8: | Partial On-Site Disposal of Waste Rock in the Drumlummon Mine Open Pits |
| Alternative 9: | Off-Site Disposal of Tailings in a Permitted Solid Waste Disposal Facility |
| Alternative 10: | Off-Site Disposal of Tailings in a RCRA-Permitted Hazardous Waste Disposal Facility |

A screening summary is presented after evaluating each alternative to identify alternatives that may be retained for further consideration and to offer rationale for exclusion of those alternatives that will no longer be considered.

### 7.2.1 Alternative 1: No Action

The no action alternative means that no actual reclamation activities will occur at the site to control contaminant migration or to reduce toxicity or volume. Preliminary screening of this alternative based on effectiveness, implementability, and cost, is described below.

<u>Effectiveness</u> - Protection of human health and the environment would not be achieved under the no action alternative.

Implementability - Implementability criteria do not apply to this alternative.

Cost Screening - No capital or operating costs would be incurred under this alternative.

Screening Summary

The no action alternative is generally used as a baseline against which other reclamation options can be compared. This alternative has been retained for further evaluation as suggested by the NCP.

### 7.2.2 Alternative 2: Institutional Controls

Institutional controls include erecting fences to restrict access to contaminated sources, and land use restrictions to prevent land development on or near the affected areas. Preliminary screening of this alternative based on effectiveness, implementability, and cost, is described below.

Effectiveness: This alternative is not fully protective of human health and the environment if implemented by itself. It would allow the waste sources to continue contributing to surface water contamination. Toxicity, mobility, and volume of the contaminated media would not be reduced under this alternative. This alternative is not practical considering the large area and easy accessibility of the waste sources. Controlling access would be very difficult because it is located in a popular recreation area and the abundance of public lands in the area of the site. It is not fully protective of human health and the environment if it is implemented as a stand alone option. No controls would be implemented for surface water or groundwater protection or for fugitive dust emissions.

Implementability: Institutional controls can be easily implemented. The alternative is applicable for minimizing direct contact and restricting future inappropriate land development if the wastes are consolidated. Materials and labor are readily available. This alternative is considered good for controlling direct contact as long as enforcement of institutional controls is maintained and deed restrictions are in place, however, long-term maintenance and monitoring of the site would be required to ensure that the controls remain in place. Administrative feasibility is considered good due to the ease of implementation. This alternative, however, is not protective of the environmental resources nor is it fully protective of human health if implemented as a stand alone alternative.

Cost Screening: The total present worth cost for institutional controls is estimated at $701,345 (Table 7-3). Costs for institutional controls would be relatively low as compared to other reclamation alternatives except no action.

Screening Summary

Institutional controls will be not considered further as a stand-alone reclamation alternative but may be used in conjunction with other alternatives.

**Table 7-3. Preliminary Cost Estimate for Alternative 2: Institutional Controls**

| Task | Quantity | Units | Unit $ | Cost $ | Comment |
|---|---|---|---|---|---|
| Mobilization, Bonding & Insurance | 1 | L.S. | 39,520 | $39,520 | 8% |
| Logistics | | | | | |
| Site Clearing/Preparation | 1 | LS | 5,000 | $5,000 | |
| Perimeter Fencing | 24,200 | LF | 20 | $484,000 | |
| Deed Restriction | 1 | LS | 5,000 | $5,000 | |
| Subtotal | | | | $533,520 | |
| Construction Oversight | 15% | | | $80,028 | |
| Subtotal Capital Costs | | | | $613,548 | |
| Contingency | 10% | | | $61,355 | |
| TOTAL CAPITAL COSTS | | | | $674,903 | |
| POST CLOSURE MONITORING AND MAINTENANCE COSTS | | | | | |
| Inspections | 1 | /Year | 250 | $250 | |
| Sampling & Analysis | 4 | /Year | 200 | $800 | |
| Maintenance | 1 | L.S. | 1500 | $1,500 | |
| Subtotal | | | | $2,550 | |
| Contingency | 10% | | | $255 | |
| TOTAL ANNUAL O&M COST | | | | $2,805 | |
| TOTAL CAPITAL COSTS | | | | $674,903 | |
| PRESENT WORTH O&M COST | 30 | yrs @ | 10% | $26,442 | |
| **TOTAL PRESENT WORTH COST** | | | | $701,345 | |

### 7.2.3 Alternative 3: Consolidation/In-Place Containment of Tailings

In general, in-place containment involves establishing vegetation on the surface of a solid media contaminant source. The purpose of establishing vegetation is to stabilize the surface by providing erosion protection and to decrease net infiltration through the waste by increasing evapotranspiration. If vegetation cannot be established directly on the waste source, cover materials may be used as a growth media. Cover materials may range from soil amendments and/or a single-layered soil cover to a complex, multi-layered cover consisting of various materials. The critical factor in the long-term stability of the an in-place containment strategy would be the control of surface runoff over the tailings.

Given the above considerations, the conceptual design for Alternative 3 involves grading of tailings piles to flatten slopes, providing surface water controls, applying a soil cover over the tailings and establishing vegetation on the tailings. Due to the fact that the Drumlummon tailings (Figure 1-5) are located within the Silver Creek stream corridor and subject to erosion, extensive run-on/run-off control would be an integral part of the in-place containment strategy. The northern portion of the Drumlummon tailings would be excavated and consolidated with the remaining Drumlummon tailings on the south side of the drainage. The tailings would be graded and Silver Creek would be rerouted to flow to the north of the in-place tailings. The graded tailings would be covered with a one-foot thick layer of cover soil.

Similarly, the Goldsil tailings (Figure 1-6) are located adjacent to Silver Creek and have a steep, exposed slope that erodes directly into Silver Creek. Extensive grading would be required to stabilize the Goldsil tailings. The Goldsil tailings are formed by dams that impound tailings on the south side of the Silver Creek Drainage. The axis of the dams run parallel to the stream drainage, rather than across the entire drainage. Therefore, the toes of these tailings dams would be left in place to take advantage of the stability provided by the dam (i.e., the toe of the dam will not be excavated or pulled back). The tailings excavated from the dam slopes would be consolidated on the remaining Goldsil tailings. The dam slopes would be reduced to approximately 3:1. The toe of the dam would be lined with riprap to provide scour protection from Silver Creek. Tailings from the lined pond area, the mill ramp area and in the vicinity of the former Goldsil mill would be consolidated with the main Goldsil tailings to reduce the area of tailings and reduce the cover soil requirements. The graded tailings would be covered with a one-foot thick layer of cover soil.

The Drumlummon millsite tailings (TP-1, TP-2 and TP-3) are located outside of the immediate Silver Creek stream corridor (Figure 3-12) and are separated from the stream by a berm. Similarly, the Upper, Middle and Lower Pond tailings are located on a bench above the Silver Creek (Figure 1-6). These tailings would be left in their existing locations and would be covered with a one-foot thick layer of cover soil. The Drumlummon millsite tailings, Drumlummon tailings, and Goldsil tailings have abundant vegetation, including trees, which will require extensive clearing and grubbing prior to capping.

The tailings piles would be revegetated after grading has been completed and cover soil has been applied The seed beds would be prepared using conventional agricultural plowing. Seeding would likely take place during the fall of the year. The seed mixture and fertilizer would be applied simultaneously to the prepared seed beds via drill application. Mulch would be applied to promote temporary protection of exposed erodible surfaces. Wheat or barley straw mulch (certified weed-free) would be applied over the excavated areas and the soil-capped tailings with a tow spreader or pneumatic spreader utilizing tucking/crimping as the anchoring mechanism. A runon/runoff control ditch would be constructed in the area of the reclaimed Drumlummon and Goldsil tailings to divert runoff away from the soil cap. Barbed-wire fencing would be placed around the graded tailings areas to allow the establishment of vegetation without interference from livestock.

Effectiveness - Waste grading and establishing vegetation would help provide short-term reduction to human health and the environment. Significant erosion protection (especially run-on/surface water control) and regular maintenance must be incorporated into the design for this alternative to remain effective in the long term. Since no actual treatment of the contaminants would be conducted, the toxicity or volume of the wastes would not be reduced.

Implementability - This alternative is both technically and administratively feasible and can be implemented with available technology and equipment.

Cost Screening - The total present-worth cost for Alternative 3 has been estimated at $1,388,221 which represents the reclamation of the mill tailings piles associated with Phases I and II of the Silver Creek Drainage Project. Table 7-4 presents the cost details associated with implementing this alternative. The total cost includes the present-worth value of 30 years of annual maintenance and monitoring costs in addition to capital costs.

Screening Summary

This alternative has been retained for detailed analysis since consolidation and in-place containment may be a feasible and cost-effective remedy for the site if adequate run-on/run-off control is provided as an integral part of the reclamation design.

### 7.2.4 Alternative 4: In-Place Containment of Waste Rock

Soil covers would be difficult to construct on the existing waste rock piles at the site because of the steep terrain. The waste rock piles would have to be graded to achieve flatter slopes to effectively place cover soil. Soil covers are often subject to severe surface water erosion problems when placed on slopes steeper than 3H:1V. Therefore, soil amendments and/or covers are not considered to be feasible on the waste rock piles. Based on field observation, erosion is not a significant problem at any of the four waste rock piles. However, waste rock pile WR4, which is located adjacent to Marysville Road (Figure 3-15) has apparently been used as a gravel borrow source. A portion of the north face of the pile has been removed and has left an over-steepened slope, similar to a highwall, which could be a potential slope stability problem.

Given the above considerations, the conceptual design for Alternative 4 involves leaving piles WR-1. WR-2 and WR-3 in place in their current conditions, and grading WR-4 to fill in the over-steepened slope. The fill would be obtained from the top of WR-4 and would be cast down the slope to reach an angle of repose slope, similar to the remainder of the north slope. Concrete median barriers would be placed around the northern perimeter of WR-4 adjacent to Marysville Road to block access. As a supplemental item to the in-place containment of the waste rock, a chain-link fence would be installed around the perimeter of the open pits at the Drumlummon mine area (Figure 3-13) to restrict access and to mitigate the fall hazard risk associated with the steep highwalls.

**Table 7-4. Preliminary Cost Estimate for Alternative 3: Consolidation/In-Place Containment of Tailings**

| Task | Quantity | Units | Unit $ | Cost $ | Comment |
|---|---|---|---|---|---|
| Mobilization, Bonding & Insurance | 1 | L.S. | 79,741 | $79,741 | 8% |
| Logistics | | | | | |
| Site Clearing/Preparation | 38.99 | Ac | 2,000 | $77,975 | |
| Debris Removal and Onsite Disposal | 1 | LS | 30,000 | $30,000 | |
| In-Place Containment | | | | | |
| Grade Drumlummon Tailings | 23,610 | CY | 2.50 | $59,025 | |
| Consolidate Goldsil Tailings | 33,540 | CY | 2.50 | $83,850 | |
| Grade Main Goldsil Tailings | 137,840 | CY | 2.00 | $275,680 | |
| Goldsil Riprap Protection | 1,000 | CY | 25.00 | $25,000 | |
| Drumlummon Stream Channel | 1,030 | LF | 80.00 | $82,400 | Piegan-Gloster |
| Cover Soil (1 foot thick)* | | | | | |
| Drumlummon Millsite Tailings | 4,507 | CY | 8.10 | $36,507 | |
| Drumlummon Tailings | 5,582 | CY | 6.60 | $36,841 | |
| Goldsil Tailings | 29,009 | CY | 4.48 | $129,960 | |
| Upper Pond | 3,591 | CY | 2.50 | $8,978 | |
| Middle Pond | 3,161 | CY | 3.10 | $9,799 | |
| Lower Pond | 2,850 | CY | 2.50 | $7,125 | |
| Water Diversion/Runon Controls | | | | | |
| Run-on Control Ditch | 3,950 | LF | 2.00 | $7,900 | |
| Revegetation | | | | | |
| Seed/Fertilize | 38.99 | Ac | 1,000 | $38,987 | |
| Mulch | 38.99 | Ac | 1,000 | $38,987 | |
| Fencing | | | | | |
| Barbed-wire Fence | 19,100 | LF | 2.50 | $47,750 | |
| Subtotal | | | | $1,076,505 | |
| Construction Oversight | 15% | | | $161,476 | |
| Subtotal Capital Costs | | | | $1,237,981 | |
| Contingency | 10% | | | $123,798 | |
| TOTAL CAPITAL COSTS | | | | $1,361,779 | |
| POST CLOSURE MONITORING AND MAINTENANCE COSTS | | | | | |
| Inspections | 1 | /Year | 250 | $250 | |
| Sampling & Analysis | 4 | /Year | 200 | $800 | |
| Maintenance | 1 | L.S. | 1500 | $1,500 | |
| Subtotal | | | | $2,550 | |
| Contingency | 10% | | | $255 | |
| TOTAL ANNUAL O&M COST | | | | $2,805 | |
| TOTAL CAPITAL COSTS | | | | $1,361,779 | |
| PRESENT WORTH O&M COST | 30 | yrs @ | 10% | $26,442 | |
| **TOTAL PRESENT WORTH COST** | | | | $1,388,221 | |

*Note: Would need to identify addtional borrow soil (approximately 17000 CY)

Effectiveness: Waste grading would help provide for improved stability of the over-steepened slope on the north face of waste rock pile WR-4. Installation of concrete traffic barriers would protect WR-4 from further excavation activities. Waste rock piles WR-1, WR-2 and WR-3 are relatively isolated and do not appear to require extensive reclamation. Since no actual treatment of the contaminants would be conducted, the toxicity or volume of the wastes would not be reduced.

Implementability: This alternative is both technically and administratively feasible and can be implemented with available technology and equipment.

Cost Screening: The total present-worth cost for Alternative 4 has been estimated at $177,343 (Table 7-5), which is significantly less than removing and disposing of the waste rock (Alternative 8).

Screening Summary

This alternative has been retained for detailed analysis since in-place containment may be a feasible and cost-effective remedy for the site, if adequate run-on/run-off control and slope stability is provided as an integral part of the reclamation design.

### 7.2.5 Alternative 5: Partial On-Site Disposal of Tailings in the Goldsil Area Repository

Three separate reclamation scenarios have been evaluated under Alternative 5. The major differences between the three scenarios have to do with the design of the liner system which would underlay the encapsulated wastes. The three scenarios considered include: 1) construction of a repository which complies with all RCRA Subtitle C regulations for hazardous waste landfill closures (this scenario includes a double-liner system with integral primary and secondary leachate collection and removal systems) and a multi-layered cap; 2) construction of a modified RCRA repository which includes a single composite liner without a leachate collection and removal system, also with a multi-layered cap; and 3) construction of an unlined repository with a multi-layered cap. Design and construction costs associated with the three scenarios will vary according to the relative degree of protection provided by the liner system (i.e., the higher the relative degree of protection provided by the liner system, the higher the associated costs). Two of the above scenarios (scenarios 2 and 3) do not comply with EPA's Minimum Technology Guidance for hazardous waste landfill closures. However, the scenarios may still provide adequate environmental protection considering the chemical and physical characteristics of the Silver Creek Drainage Project Phase I and II mine wastes, in conjunction with the physical location of the proposed repository site and the area's generally arid climate.

Each repository design scenario will be individually evaluated (if the reclamation alternatives are analyzed in detail) using the Hydrologic Evaluation Landfill Performance (HELP) Model, developed by the EPA, to determine the relative effectiveness of each design and ultimately conclude which design is most appropriate considering the anticipated expenditure (i.e., which design is most cost-effective).

The following conceptual design applies to Alternatives 5a, 5b and 5c. Under each of these three alternatives, mill tailings from the Drumlummon millsite, Drumlummon tailings area and the Goldsil tailings area will be excavated and placed in a mine waste repository located near the existing Goldsil lined pond area (Figure 1-6). The repository would be constructed in an area that encompasses the existing lined tailings pond and adjacent areas to the south and west.

**Table 7-5. Preliminary Cost Estimate for Alternative 4: In-Place Containment of Waste Rock**

| Task | Quantity | Units | Unit $ | Cost $ | Comment |
|---|---|---|---|---|---|
| Mobilization, Bonding & Insurance | 1 | L.S. | 8,836 | $8,836 | 8% |
| Logistics | | | | | |
| Site Clearing/Preparation | 3.22 | Ac | 2,000 | $6,431 | |
| Debris Removal and Onsite Disposal | 1 | LS | 5,000 | $5,000 | |
| In-Place Containment | | | | | |
| WR4 Waste Rock Grading | 2,280 | CY | 3.00 | $6,840 | |
| Water Diversion/Runon Controls | | | | | |
| Run-on Control Ditch | 1,000 | LF | 2.00 | $2,000 | |
| Revegetation | | | | | |
| Seed/Fertilize | 3.22 | Ac | 1000 | $3,216 | |
| Mulch | 3.22 | Ac | 1000 | $3,216 | |
| Concrete Barriers | 300 | LF | 30 | $9,000 | |
| Fencing | | | | | |
| Barbed-wire Fence | 5,100 | LF | 2.50 | $12,750 | |
| Open Pit Chain-Link Fence | 3100 | LF | 20 | $62,000 | |
| Subtotal | | | | $119,289 | |
| Construction Oversight | 15% | | | $17,893 | |
| Subtotal Capital Costs | | | | $137,182 | |
| Contingency | 10% | | | $13,718 | |
| TOTAL CAPITAL COSTS | | | | $150,901 | |
| POST CLOSURE MONITORING AND MAINTENANCE COSTS | | | | | |
| Inspections | 1 | /Year | 250 | $250 | |
| Sampling & Analysis | 4 | /Year | 200 | $800 | |
| Maintenance | 1 | L.S. | 1500 | $1,500 | |
| Subtotal | | | | $2,550 | |
| Contingency | 10% | | | $255 | |
| TOTAL ANNUAL O&M COST | | | | $2,805 | |
| TOTAL CAPITAL COSTS | | | | $150,901 | |
| PRESENT WORTH O&M COST | 30 | yrs @ | 10% | $26,442 | |
| **TOTAL PRESENT WORTH COST** | | | | $177,343 | |

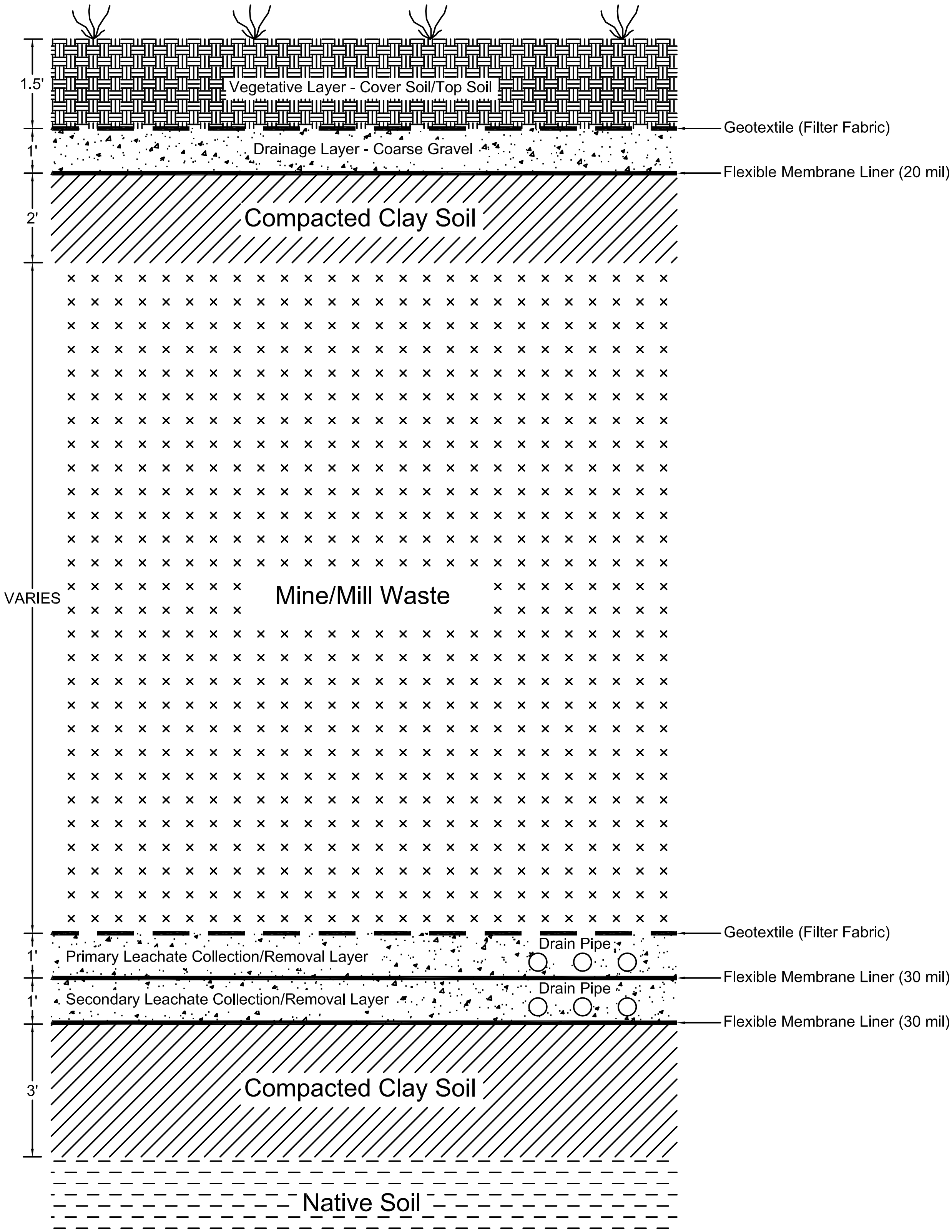
This area comprises roughly 11.8 acres that appear to be appropriate for the construction of a repository. The proposed repository site is located on a relatively flat bench above Silver Creek, and would be constructed against the existing hillside on the south side of Silver Creek. The repository lining and capping configuration differ among the three alternatives. A considerable amount of heavy equipment/machinery would be necessary to efficiently implement these alternatives. To construct the repository and load out the waste material, as well as construct runon/runoff control structures, equipment requirements would include, but not be limited to, multiple bulldozers, front end loaders and excavators. Haul trucks or scrapers would also be required to transport and deposit the contaminated material in the constructed repository. The field procedure would involve improving the existing road from the Goldsil tailings area to the Drumlummon tailings to a one lane haul road with turnouts to allow unobstructed access for heavy equipment. The number of loaders, haul trucks and/or scrapers would be maximized to the extent possible to reduce the overall time required to complete the project's construction phase.

Removal of the Drumlummon tailings would require the construction of a temporary diversion of Silver Creek while excavating the piles. After the repository construction, waste excavation, and waste placement are complete, the excavated areas would be revegetated. Cover/fill soil may be required in the excavated areas to level and contour the areas to match the surrounding terrain. The seed beds would be prepared using conventional agricultural plowing. Seeding would likely take place during the fall of the year. The seed mixture and fertilizer would be applied simultaneously to the prepared seed beds via drill application. Mulch would be applied to promote temporary protection of exposed erodible surfaces. Wheat or barley straw mulch (certified weed-free) would be applied over the excavated areas and the repository cap with a tow spreader or pneumatic spreader utilizing tucking/crimping as the anchoring mechanism. A runon/runoff control ditch would be constructed in the area of the repository to divert runoff away from the repository cap. Barbed-wire fencing would be placed around the excavated waste source areas to allow the establishment of vegetation without interference from livestock. A woven-wire fence would be constructed around the repository to limit access.

#### 7.2.5.1 Alternative 5a: Partial On-Site Disposal of Tailings in a Constructed RCRA Subtitle C Repository in the Goldsil Area

The reclamation strategy for Alternative 5a involves removing the mill tailings sources from the Drumlummon millsite, Drumlummon tailings and the Goldsil tailings and disposing these wastes in a constructed repository which complies with all RCRA Subtitle C regulations for hazardous waste landfill closures (Figure 7-1). Disposal of tailings from the Upper, Middle and Lower Pond areas are addressed separately under Alternative 6. The repository would consist of a composite, double-lined leachate collection and removal system underlying the waste in conjunction with a composite, multi-layered, lined cap overlying the waste. Assuming that the tailings volume were deposited in an area of approximately 11.8 acres, the total height of the repository would be approximately 80 feet, with a maximum waste thickness of approximately 65 feet, in order to achieve a 4:1 side slope design in the final cap.

<u>Effectiveness</u>. This alternative would effectively reduce contaminant mobility at the site by removing the highest risk solid media contaminant sources and disposing of the waste in a secure disposal facility. Consequently, the surface water erosion problems associated with the site are expected to be mitigated. Contaminant toxicity and volume would not be reduced, however, the waste would be rendered immobile in a structure and physical location protected




| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Olympus Technical Services, Inc.** | | | | | | ALTERNATIVES 5A, 6A AND 7A - ONSITE DISPOSAL IN A RCRA SUBTITLE C REPOSITORY | FIGURE 7-1 |
| Drawn: KSR | Checked: CRS | Date: 4/2003 | Job No: A138 | | | MONTANA DEQ/MINE WASTE CLEANUP BUREAU<br>SILVER CREEK DRAINAGE PROJECT<br>LEWIS & CLARK COUNTY, MONTANA | |
| Design: | Approved: | Scale: NONE | File: A1348-567A.dwg | | | | |

from erosion problems. Infiltration of precipitation through the waste sources and resulting migration of contaminants through the vadose zone and groundwater would also be significantly reduced. Long-term monitoring and control programs would be established to ensure continued effectiveness.

Implementability. This alternative is both technically and administratively feasible. The construction steps required are considered standard and conventional construction practices. Key project components, such as the availability of equipment, materials, and construction expertise, are all present and would help ensure the timely implementation and successful execution of the proposed plan.

Cost Screening. The total present-worth cost for this alternative has been estimated at $9,365,051 which represents the reclamation of all the mill tailings piles associated with Drumlummon and Goldsil millsites. Table 7-6 presents the cost details associated with implementing this alternative. The total cost includes the present-worth value of 30 years of annual maintenance and monitoring costs in addition to capital costs.

The following assumptions were used to develop costs for this alternative:

- The total volume of mill tailings to be excavated and disposed in the repository is 562,320 cy.

- The preparation of the repository base will require approximately 6,630 cy of grading to level the surface and fill in the existing lined pond.

- Bottom Liner - For cost estimating purposes, it is assumed that native soil in the area of the repository would be adequate to provide the desired hydraulic conductivity barrier layer ($\leq 1 \times 10^{-7}$ cm/sec). This compacted base layer would be 3 feet deep, and soil lifts would be applied and compacted in 6-inch intervals. A 30-mil-thick, HDPE flexible membrane liner would overlay the compacted base.

  **Note**: If native soil is not capable of providing the desired, low hydraulic conductivity via compaction, clay material would be imported, blended, and compacted with the native soil to provide the desired properties, or possibly a geosynthetic clay liner would be used in lieu of a three-feet-thick, compacted liner.

- Secondary Leachate Collection/Removal Layer - A one-foot-thick layer of washed, coarse gravel would overlay the bottom liner. PVC drain pipes would be installed in conjunction with the coarse gravel layer for leachate collection/removal. A 30-mil thick, HDPE flexible membrane liner would overlay the secondary coarse gravel layer.

- Primary Leachate Collection/Removal Layer - A one-foot-thick layer of washed, coarse gravel would overlay the secondary leachate collection/removal layer. PVC drain pipes would be installed in conjunction with the coarse gravel layer for leachate collection/removal. A geotextile filter fabric layer (to prevent potential clogging of the coarse gravel) would overlay the primary coarse gravel layer.

  **Note:** To increase space for waste disposal (and possibly reduce construction costs), synthetic drainage layers (geotextile nets) can be used in lieu of granular drainage layers in constructing the repository.

**Table 7-6. Preliminary Cost Estimate for Alternative 5a: Partial On-Site Disposal of Tailings in a Constructed RCRA Subtitle C Repository in the Goldsil Area**

| Task | Quantity | Units | Unit $ | Cost $ | Comment |
|---|---|---|---|---|---|
| Mobilization, Bonding & Insurance | 1 | L.S. | 546,837 | $546,837 | 8% |
| Logistics | | | | | |
| Access Road | 5,500 | LF | 2.00 | $11,000 | |
| Site Clearing/Preparation | 33.04 | Ac | 2,000 | $66,071 | |
| Debris Removal and Onsite Disposal | 1 | LS | 20,000 | $20,000 | |
| Repository Construction | | | | | |
| Repository Base Preparation | 6,630 | CY | 3.00 | $19,890 | |
| Repository Base Grading | 14.16 | Ac | 2,000 | $28,320 | |
| Compacted Clay Soil | 68,550 | CY | 8.00 | $548,400 | |
| 30 mil HDPE Liner | 68,550 | SY | 6.00 | $411,300 | |
| Coarse Gravel (Drain Layer) | 22,850 | CY | 20.00 | $457,000 | |
| 30 mil HDPE Liner | 68,550 | SY | 6.00 | $411,300 | |
| Coarse Gravel (Drain Layer) | 22,850 | SY | 20.00 | $457,000 | |
| Filter Fabric (geotextile) | 68,550 | SY | 3.00 | $205,650 | |
| Leachate Collection/Removal System | 1 | LS | 40,000 | $40,000 | |
| Waste Load, Haul & Dump | | | | | |
| Drumlummon Millsite Tailings | 10,570 | CY | 6.90 | $72,933 | |
| Drumlummon Tailings | 59,780 | CY | 4.30 | $257,054 | |
| Goldsil Tailings | 491,970 | CY | 2.50 | $1,229,925 | |
| Waste Grading and Compaction | 562,320 | CY | 2.00 | $1,124,640 | |
| Cap Construction | | | | | |
| Compacted Clay Soil | 38,876 | CY | 8.00 | $311,008 | |
| Install Cap Liner (20 mil HDPE) | 58,314 | SY | 5.00 | $291,570 | |
| Coarse Gravel (Cap Drain Layer) | 19,438 | CY | 20.00 | $388,760 | |
| Filter Fabric (geotextile) | 58,314 | SY | 3.00 | $174,942 | |
| Cover Soil* | | | | | |
| BS-1 | 423 | CY | 4.30 | $1,819 | |
| BS-2 | 11,100 | CY | 4.10 | $45,510 | |
| PT35 | 10,800 | CY | 5.80 | $62,640 | |
| Other (near BS-2) | 2,100 | CY | 4.10 | $8,610 | |
| Other PT (near Buck Lake) | 4,734 | CY | 5.80 | $27,457 | |
| Water Diversion/Runon Controls | | | | | |
| Run-on Control Ditch | 2,600 | LF | 2.00 | $5,200 | |
| Revegetation | | | | | |
| Seed/Fertilize | 48.24 | Ac | 1,000 | $48,244 | |
| Mulch | 48.24 | Ac | 1,000 | $48,244 | |
| Fencing | | | | | |
| Barbed-wire Fence | 17,550 | LF | 2.50 | $43,875 | |
| Repository Fence | 2,850 | LF | 6.00 | $17,100 | |
| Subtotal | | | | $7,382,299 | |
| Construction Oversight | 15% | | | $1,107,345 | |
| Subtotal Capital Costs | | | | $8,489,644 | |
| Contingency | 10% | | | $848,964 | |
| TOTAL CAPITAL COSTS | | | | $9,338,608 | |
| POST CLOSURE MONITORING AND MAINTENANCE COSTS | | | | | |
| Inspections | 1 | /Year | 250 | $250 | |
| Sampling & Analysis | 4 | /Year | 200 | $800 | |
| Maintenance | 1 | L.S. | 1500 | $1,500 | |
| Subtotal | | | | $2,550 | |
| Contingency | 10% | | | $255 | |
| TOTAL ANNUAL O&M COST | | | | $2,805 | |
| TOTAL CAPITAL COSTS | | | | $9,338,608 | |
| PRESENT WORTH O&M COST | 30 | yrs @ | 10% | $26,442 | |
| **TOTAL PRESENT WORTH COST** | | | | $9,365,051 | |

*Note: Would need to find more borrow soil (approx 4,700 CY) if Alternatives 5 and 6 used jointly

- The mine waste would be deposited over the geotextile filter fabric at an average depth of approximately 29.5 feet.

- Soil Cover - The native soil in the area of the repository would be adequate to provide the desired, low hydraulic conductivity barrier layer ($\leq 1 \times 10^{-7}$ cm/sec). This compacted layer would be 2 feet thick, and soil lifts would be applied and compacted in 6-inch intervals. A 20-mil-thick, HDPE flexible membrane liner would overlay the compacted soil layer.

  **Note:** If native soil is not capable of providing the desired, low hydraulic conductivity via compaction, clay material would be imported, blended, and compacted with the native soil to provide the desired properties, or possibly a geosynthetic clay liner would be used in lieu of a two-foot-thick, clay liner.

- Drainage Layer - A one-foot-thick layer of washed, coarse gravel would overlay the compacted soil layer. A geotextile filter fabric layer (to prevent potential clogging of the coarse gravel) would overlay the coarse gravel drainage layer.

  **Note:** To increase space for waste disposal (and possibly reduce construction costs), synthetic drainage layers (geotextile nets) can be used in lieu of granular drainage layers in constructing the repository.

- Vegetative Cover - A 1.5-foot thick layer of native soil would overlay the cap drainage layer. Cover soil would be obtained from unprocessed (i.e., overburden) placer tailings piles that were identified and sampled during the Phase I site characterization.

- Conventional plowing techniques would be adequate for preparing seed beds in the excavated source areas.

- The total surface area at the site requiring revegetation is approximately 48.24 acres, which includes the excavated source areas, repository cap and reclaimed haul roads.

- The total length of required runon/runoff control diversion ditches is approximately 2,600 lineal feet.

- The total length of fencing required to enclose the excavated waste removal areas and the repository are 17,550 and 2,850 lineal feet, respectively.

<u>Screening Summary</u>

Alternative 5a only addresses tailings from the Drumlummon and Goldsil areas. In order to address all of the tailings sources, this alternative would need to be implemented jointly with Alternative 6a, which addresses tailings from the Upper, Middle and Lower Pond areas. The combined cost of Alternatives 5a and 6a is greater than for Alternative 7a, which is a single repository of similar construction. Alternative 5a has not been retained for detailed analysis because similar effectiveness can be obtained from Alternative 7a at a lower cost.

#### 7.2.5.2 Alternative 5b: Partial On-Site Disposal of Tailings in a Constructed Modified RCRA Repository in the Goldsil Area

The reclamation strategy for Alternative 5b involves removing the mill tailings sources from the Drumlummon millsite, Drumlummon tailings and the Goldsil tailings and disposing these wastes in a constructed modified RCRA repository which includes a single composite liner (without a leachate collection and removal system) and a multi-layered cap (Figure 7-2). Disposal of tailings from the Upper, Middle and Lower Pond areas are addressed separately under Alternative 6. The repository would consist of a composite geosynthetic clay liner and 30-mil flexible membrane liner underlying the waste in conjunction with a composite, multi-layered, lined cap overlying the waste. Assuming that the tailings volume was deposited in an area of approximately 11.8 acres, the total height of the repository would be approximately 80 feet, with a maximum waste thickness of approximately 65 feet, in order to achieve a 4:1 side slope design in the final cap.

<u>Effectiveness</u> - This alternative would effectively reduce contaminant mobility at the site by removing the highest risk solid media contaminant sources and disposing of the waste in a secure disposal facility. Consequently, the surface water erosion problems associated with the site are expected to be mitigated. Contaminant toxicity and volume would not be reduced, however, the waste would be rendered immobile in a structure and physical location protected from erosion problems. Infiltration of precipitation through the waste sources and resulting migration of contaminants through the vadose zone and groundwater would also be significantly reduced. Long-term monitoring and control programs would be established to ensure continued effectiveness.

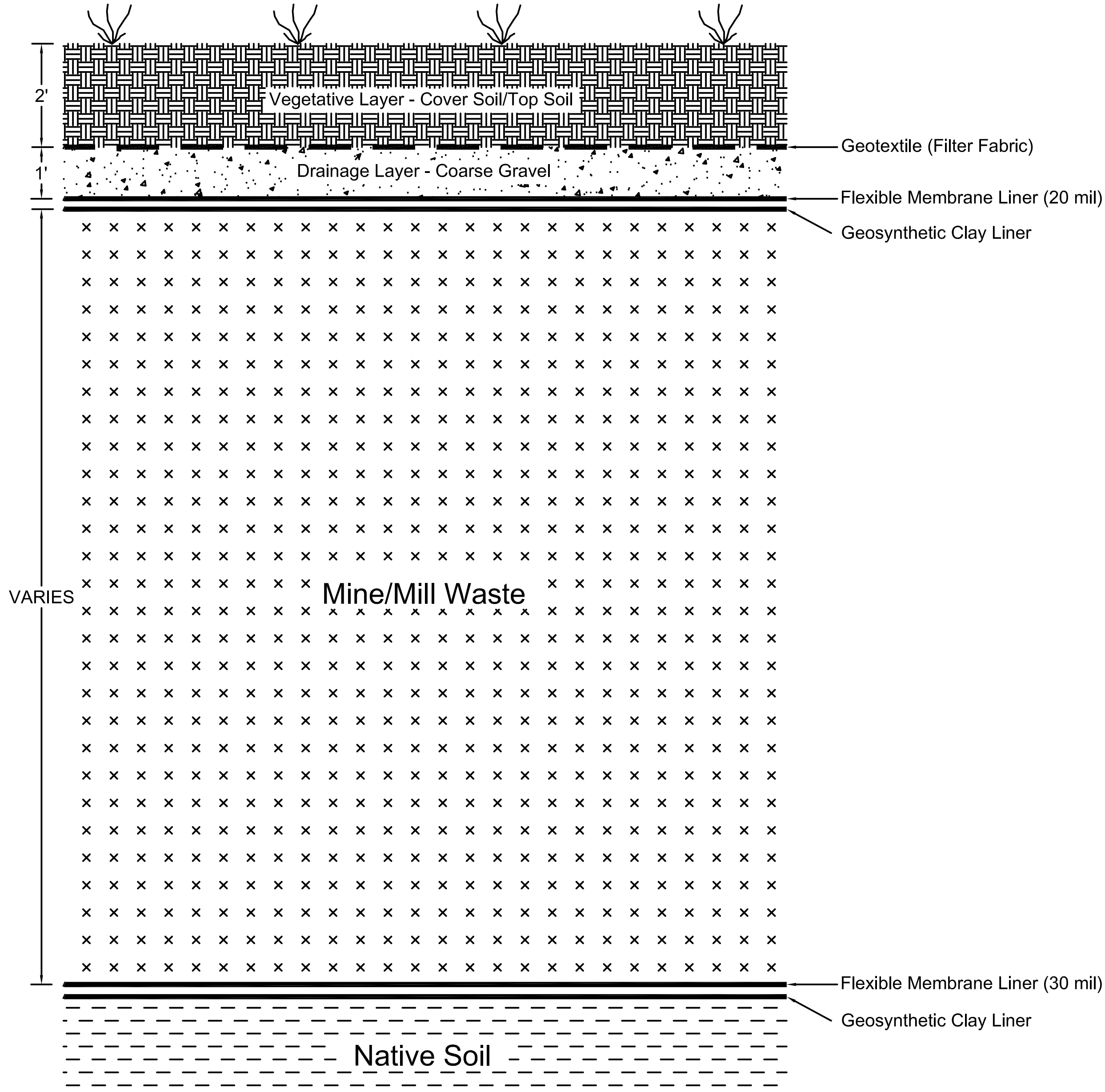
This alternative is not expected to provide as high a degree of effectiveness as provided by a constructed repository, which complies with all RCRA Subtitle C regulations (Alternative 5a), however, this alternative may provide adequate protection at a significantly reduced cost. Although this alternative does not comply with EPA's Minimum Technology Guidance, the design may provide adequate environmental protection considering the chemical and physical characteristics of the mine waste in conjunction with the physical location of the repository site and the area's generally arid climate. EPA's HELP Model could be applied to the conceptual design to determine the relative effectiveness of the design and ultimately to determine the overall feasibility of the alternative and associated cost effectiveness.

<u>Implementability</u> - This alternative is both technically and administratively feasible. The construction steps required are considered standard and conventional construction practices. Key project components, such as the availability of equipment, materials, and construction expertise, are all present and would help ensure the timely implementation and successful execution of the proposed plan.

<u>Cost Screening</u> - The total present-worth cost for this alternative has been estimated at $6,824,642 which represents the reclamation of the tailings piles associated with the Drumlummon and Goldsil millsites. Table 7-7 presents the cost details associated with implementing this alternative. The total cost includes the present-worth value of 30 years of annual maintenance and monitoring costs in addition to capital costs.

The following assumptions were used to develop costs for this alternative:

- The total volume of mill tailings to be excavated and disposed of in the repository is 562,320 cy.




| | | | | |
|---|---|---|---|---|
| **Olympus Technical Services, Inc.** | | | ALTERNATIVES 5B, 6B, 7B - ONSITE DISPOSAL IN A MODIFIED RCRA REPOSITORY | FIGURE |
| Drawn: KSR | Checked: CRS | Date: 4/2003 | Job No: A1348 | 7-2 |
| Design: | Approved: | Scale: NONE | File: A1348-567B.dwg | |

MONTANA DEQ/MINE WASTE CLEANUP BUREAU
SILVER CREEK DRAINAGE PROJECT
LEWIS & CLARK COUNTY, MONTANA

**Table 7-7. Preliminary Cost Estimate for Alternative 5b: Partial On-Site Disposal of Tailings in a Constructed Modified RCRA Repository in the Goldsil Area**

| Task | Quantity | Units | Unit $ | Cost $ | Comment |
|---|---|---|---|---|---|
| Mobilization, Bonding & Insurance | 1 | L.S. | 398,079 | $398,079 | 8% |
| Logistics | | | | | |
| Access Road | 5,500 | LF | 2.00 | $11,000 | |
| Site Clearing/Preparation | 33.04 | Ac | 2,000 | $66,071 | |
| Debris Removal and Onsite Disposal | 1 | LS | 20,000 | $20,000 | |
| Repository Construction | | | | | |
| Repository Base Preparation | 6,630 | CY | 3.00 | $19,890 | |
| Repository Base Grading | 14.16 | Ac | 2,000 | $28,320 | |
| Install Geosynthetic Clay Liner | 68,550 | SY | 4.50 | $308,475 | |
| Install 30 mil Flexible Membrane Liner | 68,550 | SY | 6.00 | $411,300 | |
| Waste Load, Haul & Dump | | | | | |
| Drumlummon Millsite Tailings | 10,570 | CY | 6.90 | $72,933 | |
| Drumlummon Tailings | 59,780 | CY | 4.30 | $257,054 | |
| Goldsil Tailings | 491,970 | CY | 2.50 | $1,229,925 | |
| Waste Grading and Compaction | 562,320 | CY | 2.00 | $1,124,640 | |
| Cap Construction | | | | | |
| Install Geosynthetic Clay Liner | 58,314 | SY | 4.50 | $262,413 | |
| Install Cap Liner (20 mil HDPE) | 58,314 | SY | 5.00 | $291,570 | |
| Coarse Gravel (Cap Drain Layer) | 19,438 | CY | 20.00 | $388,760 | |
| Filter Fabric (geotextile) | 58,314 | SY | 3.00 | $174,942 | |
| Cover Soil* | | | | | |
| BS-1 | 423 | CY | 4.30 | $1,819 | |
| BS-2 | 11,100 | CY | 4.10 | $45,510 | |
| PT35 | 10,800 | CY | 5.80 | $62,640 | |
| Other (near BS-2) | 2,100 | CY | 4.10 | $8,610 | |
| Other PT (near Buck Lake) | 4,734 | | 5.80 | $27,457 | |
| Water Diversion/Runon Controls | | | | | |
| Run-on Control Ditch | 2,600 | LF | 2.00 | $5,200 | |
| Revegetation | | | | | |
| Seed/Fertilize | 48.24 | Ac | 1,000 | $48,244 | |
| Mulch | 48.24 | Ac | 1,000 | $48,244 | |
| Fencing | | | | | |
| Barbed-wire Fence | 17,550 | LF | 2.50 | $43,875 | |
| Repository Fence | 2,850 | LF | 6.00 | $17,100 | |
| Subtotal | | | | $5,374,071 | |
| Construction Oversight | 15% | | | $806,111 | |
| Subtotal Capital Costs | | | | $6,180,182 | |
| Contingency | 10% | | | $618,018 | |
| TOTAL CAPITAL COSTS | | | | $6,798,200 | |
| POST CLOSURE MONITORING AND MAINTENANCE COSTS | | | | | |
| Inspections | 1 | /Year | 250 | $250 | |
| Sampling & Analysis | 4 | /Year | 200 | $800 | |
| Maintenance | 1 | L.S. | 1500 | $1,500 | |
| Subtotal | | | | $2,550 | |
| Contingency | 10% | | | $255 | |
| TOTAL ANNUAL O&M COST | | | | $2,805 | |
| TOTAL CAPITAL COSTS | | | | $6,798,200 | |
| PRESENT WORTH O&M COST | 30 | yrs @ | 10% | $26,442 | |
| **TOTAL PRESENT WORTH COST** | | | | $6,824,642 | |

*Note: Would need to find more borrow soil (approx 4,700 CY) if Alternatives 5 and 6 used jointly

- The preparation of the repository base will require approximately 6,630 cy of grading to level the surface and fill in the existing lined pond.

- Bottom Liner - A geosynthetic clay liner would be installed in the repository excavation. A 30-mil-thick, HDPE flexible membrane liner would overlay the geosynthetic clay liner.

- The mine waste would be deposited over the flexible membrane liner at an average depth of approximately 29.5 feet.

- Cap Liner - A geosynthetic clay liner would be installed overlaying the mine waste. A 20-mil-thick, HDPE flexible membrane liner would overlay the geosynthetic clay liner.

- Drainage Layer - A one-foot-thick layer of washed, coarse gravel would overlay the composite cap liner system. A geotextile filter fabric layer (to prevent potential clogging of the coarse gravel) would overlay the coarse gravel drainage layer.

  **Note:** To increase space for waste disposal (and possibly reduce construction costs), synthetic drainage layers (geotextile nets) can be used in lieu of granular drainage layers in constructing the repository.

- Vegetative Cover - A 1.5-foot thick layer of native soil would overlay the cap drainage layer. Cover soil would be obtained from unprocessed (i.e., overburden) placer tailings piles that were identified and sampled during the Phase I site characterization.

- Conventional plowing techniques would be adequate for preparing seed beds in the excavated source areas.

- The total surface area at the site requiring revegetation is approximately 48.24 acres, which includes the excavated source areas, repository cap and haul roads.

- The total length of required runon/runoff control diversion ditches is approximately 2,600 lineal feet.

- The total length of fencing required to enclose the excavated waste removal areas and the repository are 17,550 and 2,850 lineal feet, respectively.

<u>Screening Summary</u>

Alternative 5b only addresses tailings from the Drumlummon and Goldsil areas. In order to address all of the tailings sources, this alternative would need to be implemented jointly with Alternative 6b, which addresses tailings from the Upper, Middle and Lower Pond areas. The combined cost of Alternatives 5b and 6b is greater than for Alternative 7b, which is a single repository of similar construction. Alternative 5b has not been retained for detailed analysis because similar effectiveness can be obtained from Alternative 7b at a lower cost.

#### 7.2.5.3 Alternative 5c: Partial On-Site Disposal of Tailings in a Constructed Unlined Repository with a Multi-Layered Cap in the Goldsil Area

The reclamation strategy for Alternative 5c involves removing the mill tailings sources from the Drumlummon millsite, Drumlummon tailings and the Goldsil tailings and disposing these wastes in a constructed unlined repository with a multi-layered cap (Figure 7-3). Disposal of tailings from the Upper, Middle and Lower Pond areas are addressed separately under Alternative 6. Assuming that the tailings volume was deposited in an area of approximately 11.8 acres, the total height of the repository would be approximately 80 feet, with a maximum waste thickness of approximately 65 feet, in order to achieve a 4:1 side slope design in the final cap.

Effectiveness - This alternative would effectively reduce contaminant mobility at the site by removing the highest risk solid media contaminant sources and disposing of the waste in a secure disposal facility. Consequently, the surface water erosion problems associated with the site are expected to be mitigated. Contaminant toxicity and volume would not be reduced, however, the waste would be rendered immobile in a structure and physical location protected from erosion problems. Infiltration of precipitation through the waste sources and resulting migration of contaminants through the vadose zone and groundwater would also be significantly reduced. Long-term monitoring and control programs would be established to ensure continued effectiveness.

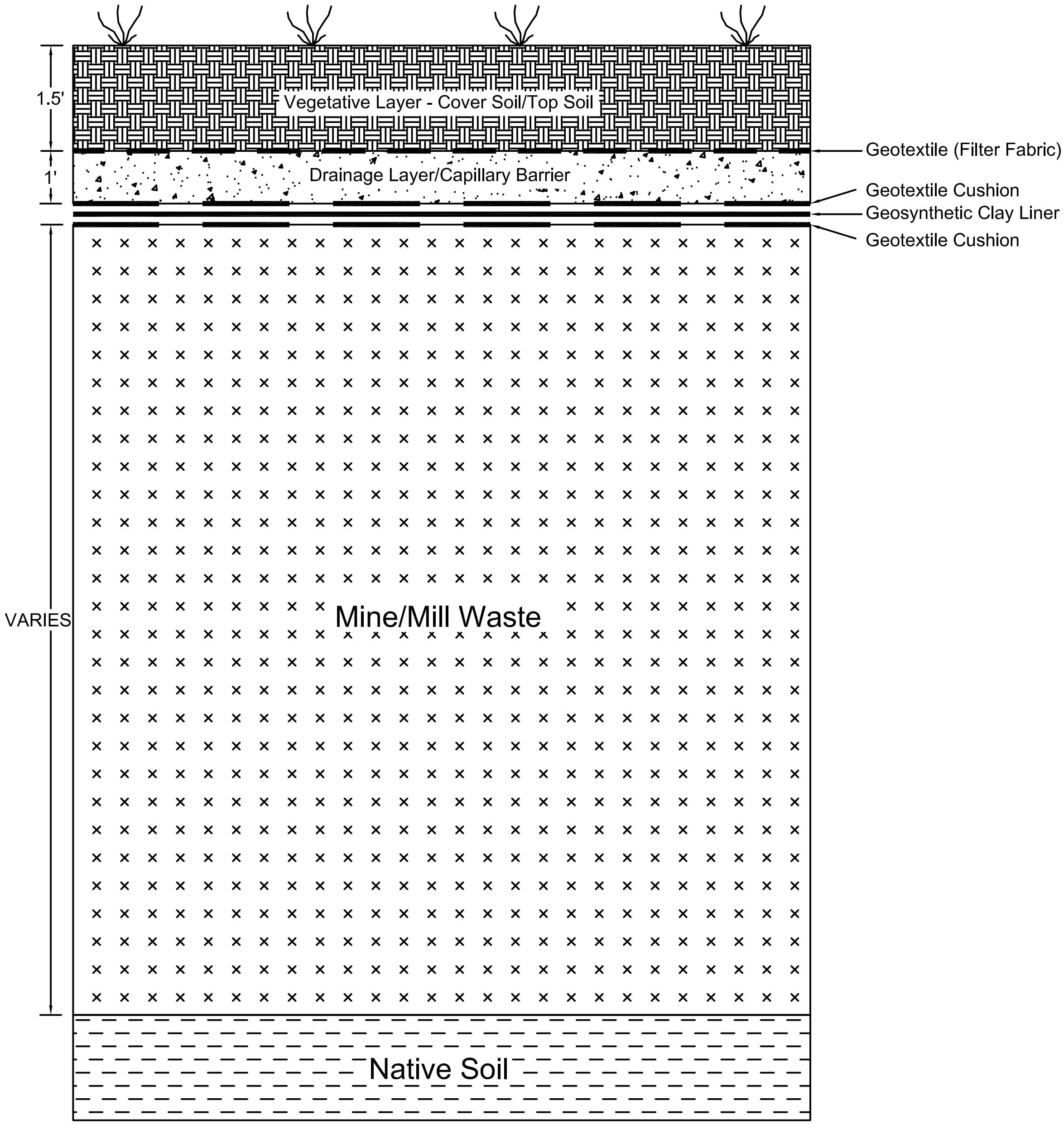
This alternative is not expected to provide as high a degree of effectiveness as provided by a constructed repository which complies with all RCRA Subtitle C regulations (Alternative 5a) or a lined repository (Alternative 5b), however, this alternative may provide adequate protection at a significantly reduced cost. Although this alternative does not comply with EPA's Minimum Technology Guidance, the design may provide adequate environmental protection considering the chemical and physical characteristics of the mine waste in conjunction with the physical location of the repository site and the area's generally arid climate. EPA's HELP Model could be applied to the conceptual design to determine the relative effectiveness of the design and ultimately to determine the overall feasibility of the alternative and associated cost effectiveness.

Implementability - This alternative is both technically and administratively feasible. The construction steps required are considered standard and conventional construction practices. Key project components, such as the availability of equipment, materials, and construction expertise, are all present and would help ensure the timely implementation and successful execution of the proposed plan.

Cost Screening - The total present-worth cost for this alternative has been estimated at $5,681,949 which represents the reclamation of the tailings piles associated with the Drumlummon and Goldsil millsites. Table 7-8 presents the cost details associated with implementing this alternative. The total cost includes the present-worth value of 30 years of annual maintenance and monitoring costs in addition to capital costs.

The following assumptions were used to develop costs for this alternative:

- The total volume of waste material to be excavated and disposed in the repository is 562,320 cy.
- The mine waste would be deposited over the repository area at an average depth of approximately 29.5 feet.
- Cap Liner - A geosynthetic clay liner would be installed overlaying the mine waste.
- Drainage Layer - A one-foot-thick layer of washed, coarse gravel would overlay the composite cap liner system. A geotextile filter fabric layer (to prevent potential clogging of the coarse gravel) would overlay the coarse gravel drainage layer.




| | | | |
|---|---|---|---|
| **Olympus Technical Services, Inc.** | | ALTERNATIVES 5C, 6C AND 7C - ONSITE DISPOSAL IN AN UNLINED REPOSITORY WITH A MULTI-LAYERED CAP | FIGURE 7-3 |
| Drawn: KSR | Checked: CRS | Date: 4/2003 | Job No: A1348 |
| Design: | Approved: | Scale: NONE | File: A1348-567C.dwg |

MONTANA DEQ/MINE WASTE CLEANUP BUREAU
SILVER CREEK DRAINAGE PROJECT
LEWIS & CLARK COUNTY, MONTANA

**Table 7-8. Preliminary Cost Estimate for Alternative 5c: Partial On-Site Disposal of Tailings in a Constructed Unlined Repository with a Multi-Layered Cap in the Goldsil Area**

| Task | Quantity | Units | Unit $ | Cost $ | Comment |
|---|---|---|---|---|---|
| Mobilization, Bonding & Insurance | 1 | L.S. | 331,167 | $331,167 | 8% |
| Logistics | | | | | |
| Access Road | 5,500 | LF | 2.00 | $11,000 | |
| Site Clearing/Preparation | 33.04 | Ac | 2,000 | $66,071 | |
| Debris Removal and Onsite Disposal | 1 | LS | 20,000 | $20,000 | |
| Repository Construction | | | | | |
| Repository Base Preparation | 6,630 | CY | 3.00 | $19,890 | |
| Repository Base Grading | 14.16 | Ac | 2,000 | $28,320 | |
| Waste Load, Haul & Dump | | | | | |
| Drumlummon Millsite Tailings | 10,570 | CY | 6.90 | $72,933 | |
| Drumlummon Tailings | 59,780 | CY | 4.30 | $257,054 | |
| Goldsil Tailings | 491,970 | CY | 2.50 | $1,229,925 | |
| Waste Grading and Compaction | 562,320 | CY | 2.00 | $1,124,640 | |
| Cap Construction | | | | | |
| Install Geotextile Cushion | 58,314 | SY | 3.00 | $174,942 | |
| Install Geosynthetic Clay Liner | 58,314 | SY | 4.50 | $262,413 | |
| Coarse Gravel (Cap Drain Layer) | 19,438 | CY | 20.00 | $388,760 | |
| Filter Fabric (geotextile) | 58,314 | SY | 3.00 | $174,942 | |
| Cover Soil* | | | | | |
| BS-1 | 423 | CY | 4.30 | $1,819 | |
| BS-2 | 11,100 | CY | 4.10 | $45,510 | |
| PT35 | 10,800 | CY | 5.80 | $62,640 | |
| Other (near BS-2) | 2,100 | CY | 4.10 | $8,610 | |
| Other PT (near Buck Lake) | 4,734 | CY | 5.80 | $27,457 | |
| Water Diversion/Runon Controls | | | | | |
| Run-on Control Ditch | 2,600 | LF | 2.00 | $5,200 | |
| Revegetation | | | | | |
| Seed/Fertilize | 48.24 | Ac | 1,000 | $48,244 | |
| Mulch | 48.24 | Ac | 1,000 | $48,244 | |
| Fencing | | | | | |
| Barbed-wire Fence | 17,550 | LF | 2.50 | $43,875 | |
| Repository Fence | 2,850 | LF | 6.00 | $17,100 | |
| Subtotal | | | | $4,470,756 | |
| Construction Oversight | 15% | | | $670,613 | |
| Subtotal Capital Costs | | | | $5,141,370 | |
| Contingency | 10% | | | $514,137 | |
| TOTAL CAPITAL COSTS | | | | $5,655,507 | |
| POST CLOSURE MONITORING AND MAINTENANCE COSTS | | | | | |
| Inspections | 1 | /Year | 250 | $250 | |
| Sampling & Analysis | 4 | /Year | 200 | $800 | |
| Maintenance | 1 | L.S. | 1500 | $1,500 | |
| Subtotal | | | | $2,550 | |
| Contingency | 10% | | | $255 | |
| TOTAL ANNUAL O&M COST | | | | $2,805 | |
| TOTAL CAPITAL COSTS | | | | $5,655,507 | |
| PRESENT WORTH O&M COST | 30 | yrs @ | 10% | $26,442 | |
| **TOTAL PRESENT WORTH COST** | | | | $5,681,949 | |

*Note: Would need to find more borrow soil (approx 4,700 CY) if Alternatives 5 and 6 used jointly

**Note:** To increase space for waste disposal (and possibly reduce construction costs), synthetic drainage layers (geotextile nets) can be used in lieu of granular drainage layers in constructing the repository.

- Vegetative Cover - A 1.5-foot thick layer of native soil would overlay the cap drainage layer. Cover soil would be obtained from unprocessed (i.e., overburden) placer tailings piles that were identified and sampled during the Phase I site characterization.

- Conventional plowing techniques would be adequate for preparing seed beds in the excavated source areas.

- The total surface area at the site requiring revegetation is approximately 48.24 acres, which includes the excavated source areas, repository cap and haul roads.

- The total length of required runon/runoff control diversion ditches is approximately 2,600 lineal feet.

- The total length of fencing required to enclose the excavated waste removal areas and the repository are 17,550 and 2,850 lineal feet, respectively.

<u>Screening Summary</u>

Alternative 5c only addresses tailings from the Drumlummon and Goldsil areas. In order to address all of the tailings sources, this alternative would need to be implemented jointly with Alternative 6c, which addresses tailings from the Upper, Middle and Lower Pond areas. The combined cost of Alternatives 5c and 6c is greater than for Alternative 7c, which is a single repository of similar construction. Alternative 5c has not been retained for detailed analysis because similar effectiveness can be obtained from Alternative 7c at a lower cost.

### 7.2.6 Alternative 6: Partial On-Site Disposal of Tailings in the Lower Pond Area Repository

Three separate reclamation scenarios have been evaluated under Alternative 6. The major differences between the three scenarios have to do with the design of the liner system which would underlay the encapsulated wastes. The three scenarios considered include: 1) construction of a repository which complies with all RCRA Subtitle C regulations for hazardous waste landfill closures (this scenario includes a double-liner system with integral primary and secondary leachate collection and removal systems) and a multi-layered cap; 2) construction of a modified RCRA repository which includes a single composite liner without a leachate collection and removal system, also with a multi-layered cap; and 3) construction of an unlined repository with a multi-layered cap. Design and construction costs associated with the three scenarios will vary according to the relative degree of protection provided by the liner system (i.e., the higher the relative degree of protection provided by the liner system, the higher the associated costs). Two of the above scenarios (scenarios 2 and 3) do not comply with EPA's Minimum Technology Guidance for hazardous waste landfill closures. However, the scenarios may still provide adequate environmental protection considering the chemical and physical characteristics of the Silver Creek Drainage Project Phase I and II mine wastes, in conjunction with the physical location of the proposed repository site and the area's generally arid climate. Each repository design scenario will be individually evaluated (if the reclamation alternatives are analyzed in detail) using the Hydrologic Evaluation Landfill Performance (HELP) Model, developed by the EPA, to determine the relative effectiveness of each design and ultimately conclude which design is most appropriate considering the anticipated expenditure (i.e., which design is most cost-effective).

The following conceptual design applies to Alternatives 6a, 6b and 6c. Under each of these three alternatives, mill tailings from the Upper, Middle and Lower Pond areas will be excavated and placed in a mine waste repository located in a former borrow area south of the Lower Pond (Figure 3-8). This area comprises roughly 3.0 acres that appear to be appropriate for the construction of a repository. The proposed repository is located well above Silver Creek, and would be constructed against the existing hillside on the south side of Silver Creek. The repository lining and capping configuration differ among the three alternatives. A considerable amount of heavy equipment/machinery would be necessary to efficiently implement these alternatives. To construct the repository and load out the waste material, as well as construct runon/runoff control structures, equipment requirements would include, but not be limited to, multiple bulldozers, front end loaders and excavators. Haul trucks or scrapers would also be required to transport and deposit the contaminated material in the constructed repository. The field procedure would involve improving the existing road from the Goldsil tailings area to the Upper, Middle and Lower Ponds areas to a one lane haul road with turnouts to allow unobstructed access for heavy equipment. The number of loaders, haul trucks and/or scrapers would be maximized to the extent possible to reduce the overall time required to complete the project's construction phase.

After the repository construction, waste excavation, and waste placement are complete, the excavated areas would be revegetated. Cover/fill soil may be required in the excavated areas to level and contour the areas to match the surrounding terrain. The seed beds would be prepared using conventional agricultural plowing. Seeding would likely take place during the fall of the year. The seed mixture and fertilizer would be applied simultaneously to the prepared seed beds via drill application. Mulch would be applied to promote temporary protection of exposed erodible surfaces. Wheat or barley straw mulch (certified weed-free) would be applied over the excavated areas and the repository cap with a tow spreader or pneumatic spreader utilizing tucking/crimping as the anchoring mechanism. A runon/runoff control ditch would be constructed in the area of the repository to divert runoff away from the repository cap. Barbed-wire fencing would be placed around the excavated waste source areas to allow the establishment of vegetation without interference from livestock. A woven-wire fence would be constructed around the repository to limit access.

#### 7.2.6.1 Alternative 6a: Partial On-Site Disposal of Tailings in a Constructed RCRA Subtitle C Repository in the Lower Pond Area

The reclamation strategy for Alternative 6a involves removing the mill tailings sources from the Upper, Middle and Lower Pond areas and disposing these wastes in a constructed repository which complies with all RCRA Subtitle C regulations for hazardous waste landfill closures (Figure 7-1). Disposal of tailings from the Drumlummon and Goldsil areas are addressed separately under Alternative 5. The repository would consist of a composite, double-lined leachate collection and removal system underlying the waste in conjunction with a composite, multi-layered, lined cap overlying the waste. Assuming that the tailings volume were deposited in an area of approximately 3.0 acres, the total height of the repository would be approximately 24 feet, with a maximum waste thickness of approximately 20 feet, in order to achieve a 4:1 side slope design in the final cap.

Effectiveness. This alternative would effectively reduce contaminant mobility at the site by removing the highest risk solid media contaminant sources and disposing of the waste in a secure disposal facility. Consequently, the surface water erosion problems associated with the site are expected to be mitigated. Contaminant toxicity and volume would not be reduced, however, the waste would be rendered immobile in a structure and physical location protected from erosion problems. Infiltration of precipitation through the waste sources and resulting migration of contaminants through the vadose zone and groundwater would also be significantly reduced. Long-term monitoring and control programs would be established to ensure continued effectiveness.

Implementability. This alternative is both technically and administratively feasible. The construction steps required are considered standard and conventional construction practices. Key project components, such as the availability of equipment, materials, and construction expertise, are all present and would help ensure the timely implementation and successful execution of the proposed plan.

Cost Screening. The total present-worth cost for this alternative has been estimated at $1,665,659 which represents the reclamation of all the mill tailings piles associated with the Upper, Middle and Lower Pond areas. Table 7-9 presents the cost details associated with implementing this alternative. The total cost includes the present-worth value of 30 years of annual maintenance and monitoring costs in addition to capital costs.

The following assumptions were used to develop costs for this alternative:

- The total volume of mill tailings to be excavated and disposed in the repository is 49,500 cy.

- The preparation of the repository base will require minimal grading to level the surface.

- Bottom Liner - For cost estimating purposes, it is assumed that native soil in the area of the repository would be adequate to provide the desired hydraulic conductivity barrier layer ($\leq 1 \times 10^{-7}$cm/sec). This compacted base layer would be 3 feet deep, and soil lifts would be applied and compacted in 6-inch intervals. A 30-mil-thick, HDPE flexible membrane liner would overlay the compacted base.

  **Note**: If native soil is not capable of providing the desired, low hydraulic conductivity via compaction, clay material would be imported, blended, and compacted with the native soil to provide the desired properties, or possibly a geosynthetic clay liner would be used in lieu of a three-feet-thick, compacted liner.

- Secondary Leachate Collection/Removal Layer - A one-foot-thick layer of washed, coarse gravel would overlay the bottom liner. PVC drain pipes would be installed in conjunction with the coarse gravel layer for leachate collection/removal. A 30-mil thick, HDPE flexible membrane liner would overlay the secondary coarse gravel layer.

- Primary Leachate Collection/Removal Layer - A one-foot-thick layer of washed, coarse gravel would overlay the secondary leachate collection/removal layer. PVC drain pipes would be installed in conjunction with the coarse gravel layer for leachate collection/removal. A geotextile filter fabric layer (to prevent potential clogging of the coarse gravel) would overlay the primary coarse gravel layer.

**Table 7-9. Preliminary Cost Estimate for Alternative 6a: Partial On-Site Disposal of Tailings in a Constructed RCRA Subtitle C Repository in the Lower Pond Area**

| Task | Quantity | Units | Unit $ | Cost $ | Comment |
|---|---|---|---|---|---|
| Mobilization, Bonding & Insurance | 1 | L.S. | 95,987 | $95,987 | 8% |
| Logistics | | | | | |
| Access Road | 7,000 | LF | 2.00 | $14,000 | |
| Site Clearing/Preparation | 5.95 | Ac | 2000 | $11,903 | |
| Debris Removal and Onsite Disposal | 1 | LS | 10,000 | $10,000 | |
| Repository Construction | | | | | |
| Repository Base Preparation | 0 | CY | 3.00 | $0 | |
| Repository Base Grading | 3.14 | Ac | 2,000 | $6,280 | |
| Compacted Clay Soil | 15,174 | CY | 8.00 | $121,392 | |
| 30 mil HDPE Liner | 15,174 | SY | 6.00 | $91,044 | |
| Coarse Gravel (Drain Layer) | 5,058 | CY | 20.00 | $101,160 | |
| 30 mil HDPE Liner | 15,174 | SY | 6.00 | $91,044 | |
| Coarse Gravel (Drain Layer) | 5,058 | SY | 20.00 | $101,160 | |
| Filter Fabric (geotextile) | 15,174 | SY | 3.00 | $45,522 | |
| Leachate Collection/Removal System | 1 | LS | 20,000 | $20,000 | |
| Waste Load, Haul & Dump | | | | | |
| Upper Pond Tailings | 20,720 | CY | 3.10 | $64,232 | |
| Middle Pond Tailings | 11,110 | CY | 2.50 | $27,775 | |
| Lower Pond Tailings | 17,670 | CY | 2.20 | $38,874 | |
| Waste Grading and Compaction | 49,500 | CY | 2.00 | $99,000 | |
| Cap Construction | | | | | |
| Compacted Clay Soil | 9,836 | CY | 8.00 | $78,688 | |
| Install Cap Liner (20 mil HDPE) | 14,754 | SY | 5.00 | $73,770 | |
| Coarse Gravel (Cap Drain Layer) | 4,918 | CY | 20.00 | $98,360 | |
| Filter Fabric (geotextile) | 14,754 | SY | 3.00 | $44,262 | |
| Cover Soil | | | | | |
| BS-1 | 7,377 | CY | 2.20 | $16,229 | |
| Water Diversion/Runon Controls | | | | | |
| Run-on Control Ditch | 1,200 | LF | 2.00 | $2,400 | |
| Revegetation | | | | | |
| Seed/Fertilize | 13.02 | Ac | 1,000 | $13,020 | |
| Mulch | 13.02 | Ac | 1,000 | $13,020 | |
| Fencing | | | | | |
| Barbed-wire Fence | 2,000 | LF | 2.50 | $5,000 | |
| Repository Fence | 1,950 | LF | 6.00 | $11,700 | |
| Subtotal | | | | $1,295,823 | |
| Construction Oversight | 15% | | | $194,373 | |
| Subtotal Capital Costs | | | | $1,490,196 | |
| Contingency | 10% | | | $149,020 | |
| TOTAL CAPITAL COSTS | | | | $1,639,216 | |
| POST CLOSURE MONITORING AND MAINTENANCE COSTS | | | | | |
| Inspections | 1 | /Year | 250 | $250 | |
| Sampling & Analysis | 4 | /Year | 200 | $800 | |
| Maintenance | 1 | L.S. | 1500 | $1,500 | |
| Subtotal | | | | $2,550 | |
| Contingency | 10% | | | $255 | |
| TOTAL ANNUAL O&M COST | | | | $2,805 | |
| TOTAL CAPITAL COSTS | | | | $1,639,216 | |
| PRESENT WORTH O&M COST | 30 | yrs @ | 10% | $26,442 | |
| **TOTAL PRESENT WORTH COST** | | | | $1,665,659 | |

**Note:** To increase space for waste disposal (and possibly reduce construction costs), synthetic drainage layers (geotextile nets) can be used in lieu of granular drainage layers in constructing the repository.

- The mine waste would be deposited over the geotextile filter fabric at an average depth of approximately 10 feet.
- Soil Cover - The native soil in the area of the repository would be adequate to provide the desired, low hydraulic conductivity barrier layer ($\leq 1 \times 10^{-7}$ cm/sec). This compacted layer would be 2 feet thick, and soil lifts would be applied and compacted in 6-inch intervals. A 20-mil-thick, HDPE flexible membrane liner would overlay the compacted soil layer.

  **Note:** If native soil is not capable of providing the desired, low hydraulic conductivity via compaction, clay material would be imported, blended, and compacted with the native soil to provide the desired properties, or possibly a geosynthetic clay liner would be used in lieu of a two-foot-thick, clay liner.

- Drainage Layer - A one-foot-thick layer of washed, coarse gravel would overlay the compacted soil layer. A geotextile filter fabric layer (to prevent potential clogging of the coarse gravel) would overlay the coarse gravel drainage layer.

  **Note:** To increase space for waste disposal (and possibly reduce construction costs), synthetic drainage layers (geotextile nets) can be used in lieu of granular drainage layers in constructing the repository.

- Vegetative Cover - A 1.5-foot thick layer of native soil would overlay the cap drainage layer. Cover soil would be obtained from unprocessed (i.e., overburden) placer tailings piles that were identified and sampled during the Phase I site characterization.
- Conventional plowing techniques would be adequate for preparing seed beds in the excavated source areas.
- The total surface area at the site requiring revegetation is approximately 13.02 acres, which includes the excavated source areas, repository cap and reclaimed haul roads.
- The total length of required runon/runoff control diversion ditches is approximately 1,200 lineal feet.
- The total length of fencing required to enclose the excavated waste removal areas and the repository are 2,000 and 1,950 lineal feet, respectively.

<u>Screening Summary</u>

Alternative 6a only addresses tailings from the Upper, Middle and Lower Pond areas. In order to address all of the tailings sources, this alternative would need to be implemented jointly with Alternative 5a, which addresses tailings from the Drumlummon and Goldsil areas. The combined cost of Alternatives 5a and 6a is greater than for Alternative 7a, which is a single repository of similar construction. Alternative 6a has not been retained for detailed analysis because similar effectiveness can be obtained from Alternative 7a at a lower cost.

#### 7.2.6.2 Alternative 6b: Partial On-Site Disposal of Tailings in a Constructed Modified RCRA Repository in the Lower Pond Area

The reclamation strategy for Alternative 6b involves removing the mill tailings sources from the Upper, Middle and Lower Pond areas and disposing these wastes in a constructed modified RCRA repository which includes a single composite liner (without a leachate collection and removal system) and a multi-layered cap (Figure 7-2). Disposal of tailings from the Drumlummon and Goldsil areas are addressed separately under Alternative 5. Assuming that the tailings volume were deposited in an area of approximately 3.0 acres, the total height of the repository would be approximately 24 feet, with a maximum waste thickness of approximately 20 feet, in order to achieve a 4:1 side slope design in the final cap.

Effectiveness - This alternative would effectively reduce contaminant mobility at the site by removing the highest risk solid media contaminant sources and disposing of the waste in a secure disposal facility. Consequently, the surface water erosion problems associated with the site are expected to be mitigated. Contaminant toxicity and volume would not be reduced, however, the waste would be rendered immobile in a structure and physical location protected from erosion problems. Infiltration of precipitation through the waste sources and resulting migration of contaminants through the vadose zone and groundwater would also be significantly reduced. Long-term monitoring and control programs would be established to ensure continued effectiveness.

This alternative is not expected to provide as high a degree of effectiveness as provided by a constructed repository, which complies with all RCRA Subtitle C regulations (Alternative 6a), however, this alternative may provide adequate protection at a significantly reduced cost. Although this alternative does not comply with EPA's Minimum Technology Guidance, the design may provide adequate environmental protection considering the chemical and physical characteristics of the mine waste in conjunction with the physical location of the repository site and the area's generally arid climate. EPA's HELP Model could be applied to the conceptual design to determine the relative effectiveness of the design and ultimately to determine the overall feasibility of the alternative and associated cost effectiveness.

Implementability - This alternative is both technically and administratively feasible. The construction steps required are considered standard and conventional construction practices. Key project components, such as the availability of equipment, materials, and construction expertise, are all present and would help ensure the timely implementation and successful execution of the proposed plan.

Cost Screening - The total present-worth cost for this alternative has been estimated at $1,085,994 which represents the reclamation of the tailings piles associated with the Upper, Middle and Lower Pond areas. Table 7-10 presents the cost details associated with implementing this alternative. The total cost includes the present-worth value of 30 years of annual maintenance and monitoring costs in addition to capital costs.

The following assumptions were used to develop costs for this alternative:

- The total volume of mill tailings to be excavated and disposed of in the repository is 49,500 cy.
- The preparation of the repository base will require minimal grading to level the surface.

**Table 7-10. Preliminary Cost Estimate for Alternative 6b: Partial On-Site Disposal of Tailings in a Constructed Modified RCRA Repository in the Lower Pond Area**

| Task | Quantity | Units | Unit $ | Cost $ | Comment |
|---|---|---|---|---|---|
| Mobilization, Bonding & Insurance | 1 | L.S. | 62,044 | $62,044 | 8% |
| Logistics | | | | | |
| Access Road | 7,000 | LF | 2.00 | $14,000 | |
| Site Clearing/Preparation | 5.95 | Ac | 2,000 | $11,903 | |
| Debris Removal and Onsite Disposal | 1 | LS | 10,000 | $10,000 | |
| Repository Construction | | | | | |
| Repository Base Preparation | 0 | CY | 3.00 | $0 | |
| Repository Base Grading | 3.14 | Ac | 2,000 | $6,280 | |
| Install Geosynthetic Clay Liner | 15,174 | SY | 4.50 | $68,283 | |
| Install 30 mil Flexible Membrane Liner | 15,174 | SY | 6.00 | $91,044 | |
| Waste Load, Haul & Dump | | | | | |
| Upper Pond Tailings | 20,720 | CY | 3.10 | $64,232 | |
| Middle Pond Tailings | 11,110 | CY | 2.50 | $27,775 | |
| Lower Pond Tailings | 17,670 | CY | 2.20 | $38,874 | |
| Waste Grading and Compaction | 49,500 | CY | 2.00 | $99,000 | |
| Cap Construction | | | | | |
| Install Geosynthetic Clay Liner | 14,754 | SY | 4.50 | $66,393 | |
| Install Cap Liner (20 mil HDPE) | 14,754 | SY | 5.00 | $73,770 | |
| Coarse Gravel (Cap Drain Layer) | 4,918 | CY | 20.00 | $98,360 | |
| Filter Fabric (geotextile) | 14,754 | SY | 3.00 | $44,262 | |
| Cover Soil | | | | | |
| BS-1 | 7,377 | CY | 2.20 | $16,229 | |
| Water Diversion/Runon Controls | | | | | |
| Run-on Control Ditch | 1,200 | LF | 2.00 | $2,400 | |
| Revegetation | | | | | |
| Seed/Fertilize | 13.02 | Ac | 1,000 | $13,020 | |
| Mulch | 13.02 | Ac | 1,000 | $13,020 | |
| Fencing | | | | | |
| Barbed-wire Fence | 2,000 | LF | 2.50 | $5,000 | |
| Repository Fence | 1,950 | LF | 6.00 | $11,700 | |
| Subtotal | | | | $837,590 | |
| Construction Oversight | 15% | | | $125,638 | |
| Subtotal Capital Costs | | | | $963,228 | |
| Contingency | 10% | | | $96,323 | |
| TOTAL CAPITAL COSTS | | | | $1,059,551 | |
| POST CLOSURE MONITORING AND MAINTENANCE COSTS | | | | | |
| Inspections | 1 | /Year | 250 | $250 | |
| Sampling & Analysis | 4 | /Year | 200 | $800 | |
| Maintenance | 1 | L.S. | 1500 | $1,500 | |
| Subtotal | | | | $2,550 | |
| Contingency | 10% | | | $255 | |
| TOTAL ANNUAL O&M COST | | | | $2,805 | |
| TOTAL CAPITAL COSTS | | | | $1,059,551 | |
| PRESENT WORTH O&M COST | 30 | yrs @ | 10% | $26,442 | |
| **TOTAL PRESENT WORTH COST** | | | | $1,085,994 | |

- Bottom Liner - A geosynthetic clay liner would be installed in the repository excavation. A 30-mil-thick, HDPE flexible membrane liner would overlay the geosynthetic clay liner.

- The mine waste would be deposited over the flexible membrane liner at an average depth of approximately 10 feet.

- Cap Liner - A geosynthetic clay liner would be installed overlaying the mine waste. A 20-mil-thick, HDPE flexible membrane liner would overlay the geosynthetic clay liner.

- Drainage Layer - A one-foot-thick layer of washed, coarse gravel would overlay the composite cap liner system. A geotextile filter fabric layer (to prevent potential clogging of the coarse gravel) would overlay the coarse gravel drainage layer.

  **Note:** To increase space for waste disposal (and possibly reduce construction costs), synthetic drainage layers (geotextile nets) can be used in lieu of granular drainage layers in constructing the repository.

- Vegetative Cover - A 1.5-foot thick layer of native soil would overlay the cap drainage layer. Cover soil would be obtained from unprocessed (i.e., overburden) placer tailings piles that were identified and sampled during the Phase I site characterization.

- Conventional plowing techniques would be adequate for preparing seed beds in the excavated source areas.

- The total surface area at the site requiring revegetation is approximately 13.02 acres, which includes the excavated source areas, repository cap and haul roads.

- The total length of required runon/runoff control diversion ditches is approximately 1,200 lineal feet.

- The total length of fencing required to enclose the excavated waste removal areas and the repository are 2,000 and 1,950 lineal feet, respectively.

<u>Screening Summary</u>

Alternative 6b only addresses tailings from the Upper, Middle and Lower Pond areas. In order to address all of the tailings sources, this alternative would need to be implemented jointly with Alternative 5b, which addresses tailings from the Drumlummon and Goldsil areas. The combined cost of Alternatives 5b and 6b is greater than for Alternative 7b, which is a single repository of similar construction. Alternative 6b has not been retained for detailed analysis because similar effectiveness can be obtained from Alternative 7b at a lower cost.

#### 7.2.6.3 Alternative 6c: Partial On-Site Disposal of Tailings in a Constructed Unlined Repository with a Multi-Layered Cap in the Lower Pond Area

The reclamation strategy for Alternative 6c involves removing the mill tailings sources from the Upper, Middle and Lower Pond areas and disposing these wastes in a constructed unlined repository with a multi-layered cap (Figure 7-3). Disposal of tailings from the Drumlummon and Goldsil areas are addressed separately under Alternative 5. Assuming that the tailings volume were deposited in an area of approximately 3.0 acres, the total height of the repository would be approximately 24 feet, with a maximum waste thickness of approximately 20 feet, in order to achieve a 4:1 side slope design in the final cap.

Effectiveness - This alternative would effectively reduce contaminant mobility at the site by removing the highest risk solid media contaminant sources and disposing of the waste in a secure disposal facility. Consequently, the surface water erosion problems associated with the site are expected to be mitigated. Contaminant toxicity and volume would not be reduced, however, the waste would be rendered immobile in a structure and physical location protected from erosion problems. Infiltration of precipitation through the waste sources and resulting migration of contaminants through the vadose zone and groundwater would also be significantly reduced. Long-term monitoring and control programs would be established to ensure continued effectiveness.

This alternative is not expected to provide as high a degree of effectiveness as provided by a constructed repository which complies with all RCRA Subtitle C regulations (Alternative 6a) or a lined repository (Alternative 6b), however, this alternative may provide adequate protection at a significantly reduced cost. Although this alternative does not comply with EPA's Minimum Technology Guidance, the design may provide adequate environmental protection considering the chemical and physical characteristics of the mine waste in conjunction with the physical location of the repository site and the area's generally arid climate. EPA's HELP Model could be applied to the conceptual design to determine the relative effectiveness of the design and ultimately to determine the overall feasibility of the alternative and associated cost effectiveness.

Implementability - This alternative is both technically and administratively feasible. The construction steps required are considered standard and conventional construction practices. Key project components, such as the availability of equipment, materials, and construction expertise, are all present and would help ensure the timely implementation and successful execution of the proposed plan.

Cost Screening - The total present-worth cost for this alternative has been estimated at $828,007 which represents the reclamation of the tailings piles associated with the Upper, Middle and Lower Pond areas. Table 7-11 presents the cost details associated with implementing this alternative. The total cost includes the present-worth value of 30 years of annual maintenance and monitoring costs in addition to capital costs.

The following assumptions were used to develop costs for this alternative:

- The total volume of waste material to be excavated and disposed in the repository is 49,520 cy.
- The mine waste would be deposited over the repository area at an average depth of approximately 10 feet.
- Cap Liner - A geosynthetic clay liner would be installed overlaying the mine waste.
- Drainage Layer - A one-foot-thick layer of washed, coarse gravel would overlay the composite cap liner system. A geotextile filter fabric layer (to prevent potential clogging of the coarse gravel) would overlay the coarse gravel drainage layer.

**Table 7-11. Preliminary Cost Estimate for Alternative 6c: Partial On-Site Disposal of Tailings in a Constructed Unlined Repository with a Multi-Layered Cap in the Lower Pond Area**

| Task | Quantity | Units | Unit $ | Cost $ | Comment |
|---|---|---|---|---|---|
| Mobilization, Bonding & Insurance | 1 | L.S. | 46,937 | $46,937 | 8% |
| Logistics | | | | | |
| Access Road | 7,000 | LF | 2.00 | $14,000 | |
| Site Clearing/Preparation | 5.95 | Ac | 2,000 | $11,903 | |
| Debris Removal and Onsite Disposal | 1 | LS | 10,000 | $10,000 | |
| Repository Construction | | | | | |
| Repository Base Preparation | 0 | CY | 3.00 | $0 | |
| Repository Base Grading | 3.14 | Ac | 2,000 | $6,280 | |
| Waste Load, Haul & Dump | | | | | |
| Upper Pond Tailings | 20,720 | CY | 3.10 | $64,232 | |
| Middle Pond Tailings | 11,110 | CY | 2.50 | $27,775 | |
| Lower Pond Tailings | 17,670 | CY | 2.20 | $38,874 | |
| Waste Grading and Compaction | 49,500 | CY | 2.00 | $99,000 | |
| Cap Construction | | | | | |
| Install Geotextile Cushion | 14,754 | SY | 3.00 | $44,262 | |
| Install Geosynthetic Clay Liner | 14,754 | SY | 4.50 | $66,393 | |
| Coarse Gravel (Cap Drain Layer) | 4,918 | CY | 20.00 | $98,360 | |
| Filter Fabric (geotextile) | 14,754 | SY | 3.00 | $44,262 | |
| Cover Soil | | | | | |
| BS-1 | 7,377 | CY | 2.20 | $16,229 | |
| Water Diversion/Runon Controls | | | | | |
| Run-on Control Ditch | 1,200 | LF | 2.00 | $2,400 | |
| Revegetation | | | | | |
| Seed/Fertilize | 13.02 | Ac | 1,000 | $13,020 | |
| Mulch | 13.02 | Ac | 1,000 | $13,020 | |
| Fencing | | | | | |
| Barbed-wire Fence | 2,000 | LF | 2.50 | $5,000 | |
| Repository Fence | 1,950 | LF | 6.00 | $11,700 | |
| Subtotal | | | | $633,648 | |
| Construction Oversight | 15% | | | $95,047 | |
| Subtotal Capital Costs | | | | $728,695 | |
| Contingency | 10% | | | $72,870 | |
| TOTAL CAPITAL COSTS | | | | $801,565 | |
| POST CLOSURE MONITORING AND MAINTENANCE COSTS | | | | | |
| Inspections | 1 | /Year | 250 | $250 | |
| Sampling & Analysis | 4 | /Year | 200 | $800 | |
| Maintenance | 1 | L.S. | 1500 | $1,500 | |
| Subtotal | | | | $2,550 | |
| Contingency | 10% | | | $255 | |
| TOTAL ANNUAL O&M COST | | | | $2,805 | |
| TOTAL CAPITAL COSTS | | | | $801,565 | |
| PRESENT WORTH O&M COST | 30 | yrs @ | 10% | $26,442 | |
| **TOTAL PRESENT WORTH COST** | | | | $828,007 | |

**Note:** To increase space for waste disposal (and possibly reduce construction costs), synthetic drainage layers (geotextile nets) can be used in lieu of granular drainage layers in constructing the repository.

- Vegetative Cover - A 1.5-foot thick layer of native soil would overlay the cap drainage layer. Cover soil would be obtained from unprocessed (i.e., overburden) placer tailings piles that were identified and sampled during the Phase I site characterization.

- Conventional plowing techniques would be adequate for preparing seed beds in the excavated source areas.

- The total surface area at the site requiring revegetation is approximately 13.02 acres, which includes the excavated source areas, repository cap and haul roads.

- The total length of required runon/runoff control diversion ditches is approximately 1,200 lineal feet.

- The total length of fencing required to enclose the excavated waste removal areas and the repository are 2,000 and 1,950 lineal feet, respectively.

Screening Summary

Alternative 6c only addresses tailings from the Upper, Middle and Lower Pond areas. In order to address all of the tailings sources, this alternative would need to be implemented jointly with Alternative 5c, which addresses tailings from the Drumlummon and Goldsil areas. The combined cost of Alternatives 5c and 6c is greater than for Alternative 7c, which is a single repository of similar construction. Alternative 6c has not been retained for detailed analysis because similar effectiveness can be obtained from Alternative 7c at a lower cost.

### 7.2.7 Alternative 7: On-Site Disposal of Tailings in the Goldsil Area Repository

Three separate reclamation scenarios have been evaluated under Alternative 7. The major differences between the three scenarios have to do with the design of the liner system which would underlay the encapsulated wastes. The three scenarios considered include: 1) construction of a repository which complies with all RCRA Subtitle C regulations for hazardous waste landfill closures (this scenario includes a double-liner system with integral primary and secondary leachate collection and removal systems) and a multi-layered cap; 2) construction of a modified RCRA repository which includes a single composite liner without a leachate collection and removal system, also with a multi-layered cap; and 3) construction of an unlined repository with a multi-layered cap. Design and construction costs associated with the three scenarios will vary according to the relative degree of protection provided by the liner system (i.e., the higher the relative degree of protection provided by the liner system, the higher the associated costs). Two of the above scenarios (scenarios 2 and 3) do not comply with EPA's Minimum Technology Guidance for hazardous waste landfill closures. However, the scenarios may still provide adequate environmental protection considering the chemical and physical characteristics of the Silver Creek Drainage Project Phase I and II mine wastes, in conjunction with the physical location of the proposed repository site and the area's generally arid climate. Each repository design scenario will be individually evaluated (if the reclamation alternatives are analyzed in detail) using the Hydrologic Evaluation Landfill Performance (HELP) Model, developed by the EPA, to determine the relative effectiveness of each design and ultimately conclude which design is most appropriate considering the anticipated expenditure (i.e., which design is most cost-effective).

The following conceptual design applies to Alternatives 7a, 7b and 7c. Under each of these three alternatives, mill tailings from the Drumlummon millsite, Drumlummon tailings area, Goldsil tailings area and the Upper, Middle and Lower Pond areas will be excavated and placed in a mine waste repository located near the existing Goldsil lined pond area (Figure 1-6). The repository would be constructed in an area that encompasses the existing lined tailings pond and adjacent areas to the south and west. This area comprises roughly 12.6 acres that appear to be appropriate for the construction of a repository. The proposed repository site is located on a relatively flat bench above Silver Creek, and would be constructed against the existing hillside on the south side of Silver Creek. The repository lining and capping configuration differ among the three alternatives. A considerable amount of heavy equipment/machinery would be necessary to efficiently implement these alternatives. To construct the repository and load out the waste material, as well as construct runon/runoff control structures, equipment requirements would include, but not be limited to, multiple bulldozers, front end loaders and excavators. Haul trucks or scrapers would also be required to transport and deposit the contaminated material in the constructed repository. The field procedure would involve improving the existing road from the Goldsil tailings area to the Drumlummon tailings and to the Upper, Middle and Lower Pond areas to a one lane haul road with turnouts to allow unobstructed access for heavy equipment. The number of loaders, haul trucks and/or scrapers would be maximized to the extent possible to reduce the overall time required to complete the project's construction phase.

Removal of the Drumlummon tailings would require the construction of a temporary diversion of Silver Creek while excavating the tailings. After the repository construction, waste excavation, and waste placement are complete, the excavated areas would be revegetated. Cover/fill soil may be required in the excavated areas to level and contour the areas to match the surrounding terrain. The seed beds would be prepared using conventional agricultural plowing. Seeding would likely take place during the fall of the year. The seed mixture and fertilizer would be applied simultaneously to the prepared seed beds via drill application. Mulch would be applied to promote temporary protection of exposed erodible surfaces. Wheat or barley straw mulch (certified weed-free) would be applied over the excavated areas and the repository cap with a tow spreader or pneumatic spreader utilizing tucking/crimping as the anchoring mechanism. A runon/runoff control ditch would be constructed in the area of the repository to divert runoff away from the repository cap. Barbed-wire fencing would be placed around the excavated waste source areas to allow the establishment of vegetation without interference from livestock. A woven-wire fence would be constructed around the repository to limit access.

#### 7.2.7.1 Alternative 7a: On-Site Disposal of Tailings in a Constructed RCRA Subtitle C Repository in the Goldsil Area

The reclamation strategy for Alternative 7a involves removing the mill tailings sources from the Drumlummon millsite, Drumlummon tailings area, Goldsil tailings area and the Upper, Middle and Lower Pond areas and disposing these wastes in a constructed repository which complies with all RCRA Subtitle C regulations for hazardous waste landfill closures (Figure 7-1). The repository would consist of a composite, double-lined leachate collection and removal system underlying the waste in conjunction with a composite, multi-layered, lined cap overlying the waste. Assuming that the tailings volume was deposited in an area of approximately 12.6 acres, the total height of the repository would be approximately 100 feet, with a maximum waste thickness of approximately 70 feet, in order to achieve a 4:1 side slope design in the final cap.

Effectiveness. This alternative would effectively reduce contaminant mobility at the site by removing the highest risk solid media contaminant sources and disposing of the waste in a secure disposal facility. Consequently, the surface water erosion problems associated with the site are expected to be mitigated. Contaminant toxicity and volume would not be reduced, however, the waste would be rendered immobile in a structure and physical location protected from erosion problems. Infiltration of precipitation through the waste sources and resulting migration of contaminants through the vadose zone and groundwater would also be significantly reduced. Long-term monitoring and control programs would be established to ensure continued effectiveness.

Implementability. This alternative is both technically and administratively feasible. The construction steps required are considered standard and conventional construction practices. Key project components, such as the availability of equipment, materials, and construction expertise, are all present and would help ensure the timely implementation and successful execution of the proposed plan.

Cost Screening. The total present-worth cost for this alternative has been estimated at $10,182,511 which represents the reclamation of all of the mill tailings piles associated with Phases I and II of the Silver Creek Drainage Project. Table 7-12 presents the cost details associated with implementing this alternative. The total cost includes the present-worth value of 30 years of annual maintenance and monitoring costs in addition to capital costs.

The following assumptions were used to develop costs for this alternative:

- The total volume of mill tailings to be excavated and disposed in the repository is 611,820 cy.

- The preparation of the repository base will require approximately 6,630 cy of grading to level the surface and fill in the existing lined pond.

- Bottom Liner - For cost estimating purposes, it is assumed that native soil in the area of the repository would be adequate to provide the desired hydraulic conductivity barrier layer ($\leq 1 \times 10^{-7}$cm/sec). This compacted base layer would be 3 feet deep, and soil lifts would be applied and compacted in 6-inch intervals. A 30-mil-thick, HDPE flexible membrane liner would overlay the compacted base.

  **Note**: If native soil is not capable of providing the desired, low hydraulic conductivity via compaction, clay material would be imported, blended, and compacted with the native soil to provide the desired properties, or possibly a geosynthetic clay liner would be used in lieu of a three-feet-thick, compacted liner.

- Secondary Leachate Collection/Removal Layer - A one-foot-thick layer of washed, coarse gravel would overlay the bottom liner. PVC drain pipes would be installed in conjunction with the coarse gravel layer for leachate collection/removal. A 30-mil thick, HDPE flexible membrane liner would overlay the secondary coarse gravel layer.

- Primary Leachate Collection/Removal Layer - A one-foot-thick layer of washed, coarse gravel would overlay the secondary leachate collection/removal layer. PVC drain pipes would be installed in conjunction with the coarse gravel layer for leachate collection/removal. A geotextile filter fabric layer (to prevent potential clogging of the coarse gravel) would overlay the primary coarse gravel layer.

**Table 7-12. Preliminary Cost Estimate for Alternative 7a: On-Site Disposal of Tailings in a Constructed RCRA Subtitle C Repository in the Goldsil Area**

| Task | Quantity | Units | Unit $ | Cost $ | Comment |
|---|---|---|---|---|---|
| Mobilization, Bonding & Insurance | 1 | L.S. | 594,705 | $594,705 | 8% |
| Logistics | | | | | |
| Access Road | 12,500 | LF | 2.00 | $25,000 | |
| Site Clearing/Preparation | 38.99 | Ac | 2,000 | $77,975 | |
| Debris Removal and Onsite Disposal | 1 | LS | 30,000 | $30,000 | |
| Repository Construction | | | | | |
| Repository Base Preparation | 6,630 | CY | 3.00 | $19,890 | |
| Repository Base Grading | 14.94 | Ac | 2,000 | $29,880 | |
| Compacted Clay Soil | 72,321 | CY | 8.00 | $578,568 | |
| 30 mil HDPE Liner | 72,321 | SY | 6.00 | $433,926 | |
| Coarse Gravel (Drain Layer) | 24,107 | CY | 20.00 | $482,140 | |
| 30 mil HDPE Liner | 72,321 | SY | 6.00 | $433,926 | |
| Coarse Gravel (Drain Layer) | 24,107 | SY | 20.00 | $482,140 | |
| Filter Fabric (geotextile) | 72,321 | SY | 3.00 | $216,963 | |
| Leachate Collection/Removal System | 1 | LS | 45,000 | $45,000 | |
| Waste Load, Haul & Dump | | | | | |
| Drumlummon Millsite Tailings | 10,570 | CY | 6.90 | $72,933 | |
| Drumlummon Tailings | 59,780 | CY | 4.30 | $257,054 | |
| Goldsil Tailings | 491,970 | CY | 2.50 | $1,229,925 | |
| Upper Pond Tailings | 20,720 | CY | 4.20 | $87,024 | |
| Middle Pond Tailings | 11,110 | CY | 4.30 | $47,773 | |
| Lower Pond Tailings | 17,670 | CY | 4.40 | $77,748 | |
| Waste Grading and Compaction | 611,820 | CY | 2.00 | $1,223,640 | |
| Cap Construction | | | | | |
| Compacted Clay Soil | 41,647 | CY | 8.00 | $333,176 | |
| Install Cap Liner (20 mil HDPE) | 62,470 | SY | 5.00 | $312,350 | |
| Coarse Gravel (Cap Drain Layer) | 20,823 | CY | 20.00 | $416,460 | |
| Filter Fabric (geotextile) | 62,470 | SY | 3.00 | $187,410 | |
| Cover Soil | | | | | |
| BS-1 | 7,800 | CY | 4.30 | $33,540 | |
| BS-2 | 11,100 | CY | 4.10 | $45,510 | |
| PT35 | 10,800 | CY | 5.80 | $62,640 | |
| Other (near BS-2) | 1,535 | CY | 4.10 | $6,294 | |
| Water Diversion/Runon Controls | | | | | |
| Run-on Control Ditch | 2,600 | LF | 2.00 | $5,200 | |
| Revegetation | | | | | |
| Seed/Fertilize | 59.07 | Ac | 1,000 | $59,074 | |
| Mulch | 59.07 | Ac | 1,000 | $59,074 | |
| Fencing | | | | | |
| Barbed-wire Fence | 17,550 | LF | 2.50 | $43,875 | |
| Repository Fence | 2,950 | LF | 6.00 | $17,700 | |
| Subtotal | | | | $8,028,513 | |
| Construction Oversight | 15% | | | $1,204,277 | |
| Subtotal Capital Costs | | | | $9,232,790 | |
| Contingency | 10% | | | $923,279 | |
| TOTAL CAPITAL COSTS | | | | $10,156,069 | |
| POST CLOSURE MONITORING AND MAINTENANCE COSTS | | | | | |
| Inspections | 1 | /Year | 250 | $250 | |
| Sampling & Analysis | 4 | /Year | 200 | $800 | |
| Maintenance | 1 | L.S. | 1500 | $1,500 | |
| Subtotal | | | | $2,550 | |
| Contingency | 10% | | | $255 | |
| TOTAL ANNUAL O&M COST | | | | $2,805 | |
| TOTAL CAPITAL COSTS | | | | $10,156,069 | |
| PRESENT WORTH O&M COST | 30 | yrs @ | 10% | $26,442 | |
| **TOTAL PRESENT WORTH COST** | | | | $10,182,511 | |

**Note:** To increase space for waste disposal (and possibly reduce construction costs), synthetic drainage layers (geotextile nets) can be used in lieu of granular drainage layers in constructing the repository.

- The mine waste would be deposited over the geotextile filter fabric at an average depth of approximately 30 feet.

- Soil Cover - The native soil in the area of the repository would be adequate to provide the desired, low hydraulic conductivity barrier layer ($\leq 1 \times 10^{-7}$ cm/sec). This compacted layer would be 2 feet thick, and soil lifts would be applied and compacted in 6-inch intervals. A 20-mil-thick, HDPE flexible membrane liner would overlay the compacted soil layer.

  **Note:** If native soil is not capable of providing the desired, low hydraulic conductivity via compaction, clay material would be imported, blended, and compacted with the native soil to provide the desired properties, or possibly a geosynthetic clay liner would be used in lieu of a two-foot-thick, clay liner.

- Drainage Layer - A one-foot-thick layer of washed, coarse gravel would overlay the compacted soil layer. A geotextile filter fabric layer (to prevent potential clogging of the coarse gravel) would overlay the coarse gravel drainage layer.

  **Note:** To increase space for waste disposal (and possibly reduce construction costs), synthetic drainage layers (geotextile nets) can be used in lieu of granular drainage layers in constructing the repository.

- Vegetative Cover - A 1.5-foot thick layer of native soil would overlay the cap drainage layer. Cover soil would be obtained from unprocessed (i.e., overburden) placer tailings piles that were identified and sampled during the Phase I site characterization.

- Conventional plowing techniques would be adequate for preparing seed beds in the excavated source areas.

- The total surface area at the site requiring revegetation is approximately 59.07 acres, which includes the excavated source areas, repository cap and reclaimed haul roads.

- The total length of required runon/runoff control diversion ditches is approximately 2,600 lineal feet.

- The total length of fencing required to enclose the excavated waste removal areas and the repository are 17,550 and 2,950 lineal feet, respectively.

Screening Summary

This alternative has not been retained for detailed analysis because of cost. A similar degree of effectiveness can be obtained from Alternative 7b at a significantly lower cost.

#### 7.2.7.2 Alternative 7b: On-Site Disposal of Tailings in a Constructed Modified RCRA Repository in the Goldsil Area

The reclamation strategy for Alternative 7b involves removing mill tailings sources from the Drumlummon millsite, Drumlummon tailings area, Goldsil tailings area and the Upper, Middle and Lower Pond areas and disposing these wastes in a constructed modified RCRA repository which includes a single composite liner (without a leachate collection and removal system) and a multi-layered cap (Figure 7-2). Assuming that the tailings volume was deposited in an area of approximately 12.6 acres, the total height of the repository would be approximately 100 feet, with a maximum waste thickness of approximately 70 feet, in order to achieve a 4:1 side slope design in the final cap.

<u>Effectiveness</u> - This alternative would effectively reduce contaminant mobility at the site by removing the highest risk solid media contaminant sources and disposing of the waste in a secure disposal facility. Consequently, the surface water erosion problems associated with the site are expected to be mitigated. Contaminant toxicity and volume would not be reduced, however, the waste would be rendered immobile in a structure and physical location protected from erosion problems. Infiltration of precipitation through the waste sources and resulting migration of contaminants through the vadose zone and groundwater would also be significantly reduced. Long-term monitoring and control programs would be established to ensure continued effectiveness.

This alternative is not expected to provide as high a degree of effectiveness as provided by a constructed repository, which complies with all RCRA Subtitle C regulations (Alternative 7a), however, this alternative may provide adequate protection at a significantly reduced cost. Although this alternative does not comply with EPA's Minimum Technology Guidance, the design may provide adequate environmental protection considering the chemical and physical characteristics of the mine waste in conjunction with the physical location of the repository site and the area's generally arid climate. EPA's HELP Model could be applied to the conceptual design to determine the relative effectiveness of the design and ultimately to determine the overall feasibility of the alternative and associated cost effectiveness.

<u>Implementability</u> - This alternative is both technically and administratively feasible. The construction steps required are considered standard and conventional construction practices. Key project components, such as the availability of equipment, materials, and construction expertise, are all present and would help ensure the timely implementation and successful execution of the proposed plan.

<u>Cost Screening</u> - The total present-worth cost for this alternative has been estimated at $7,497,444 which represents the reclamation of all of the mill tailings piles associated with Phases I and II of the Silver Creek Drainage Project. Table 7-13 presents the cost details associated with implementing this alternative. The total cost includes the present-worth value of 30 years of annual maintenance and monitoring costs in addition to capital costs.

The following assumptions were used to develop costs for this alternative:

- The total volume of mill tailings to be excavated and disposed of in the repository is 611,820 cy.
- The preparation of the repository base will require approximately 6,630 cy of grading to level the surface and fill in the existing lined pond.

**Table 7-13. Preliminary Cost Estimate for Alternative 7b: On-Site Disposal of Tailings in a Constructed Modified RCRA Repository in the Goldsil Area**

| Task | Quantity | Units | Unit $ | Cost $ | Comment |
|---|---|---|---|---|---|
| Mobilization, Bonding & Insurance | 1 | L.S. | 437,476 | $437,476 | 8% |
| Logistics | | | | | |
| Access Road | 12,500 | LF | 2.00 | $25,000 | |
| Site Clearing/Preparation | 38.99 | Ac | 2,000 | $77,975 | |
| Debris Removal and Onsite Disposal | 1 | LS | 30,000 | $30,000 | |
| Repository Construction | | | | | |
| Repository Base Preparation | 6,630 | CY | 3.00 | $19,890 | |
| Repository Base Grading | 14.94 | Ac | 2,000 | $29,880 | |
| Install Geosynthetic Clay Liner | 72,321 | SY | 4.50 | $325,445 | |
| Install 30 mil Flexible Membrane Liner | 72,321 | SY | 6.00 | $433,926 | |
| Waste Load, Haul & Dump | | | | | |
| Drumlummon Millsite Tailings | 10,570 | CY | 6.90 | $72,933 | |
| Drumlummon Tailings | 59,780 | CY | 4.30 | $257,054 | |
| Goldsil Tailings | 491,970 | CY | 2.50 | $1,229,925 | |
| Upper Pond Tailings | 20,720 | CY | 4.20 | $87,024 | |
| Middle Pond Tailings | 11,110 | CY | 4.30 | $47,773 | |
| Lower Pond Tailings | 17,670 | CY | 4.40 | $77,748 | |
| Waste Grading and Compaction | 611,820 | CY | 2.00 | $1,223,640 | |
| Cap Construction | | | | | |
| Install Geosynthetic Clay Liner | 62,470 | SY | 4.50 | $281,115 | |
| Install Cap Liner (20 mil HDPE) | 62,470 | SY | 5.00 | $312,350 | |
| Coarse Gravel (Cap Drain Layer) | 20,823 | CY | 20.00 | $416,460 | |
| Filter Fabric (geotextile) | 62,470 | SY | 3.00 | $187,410 | |
| Cover Soil | | | | | |
| BS-1 | 7,800 | CY | 4.30 | $33,540 | |
| BS-2 | 11,100 | CY | 4.10 | $45,510 | |
| PT35 | 10,800 | CY | 5.80 | $62,640 | |
| Other (near BS-2) | 1,535 | CY | 4.10 | $6,294 | |
| Water Diversion/Runon Controls | | | | | |
| Run-on Control Ditch | 2,600 | LF | 2.00 | $5,200 | |
| Revegetation | | | | | |
| Seed/Fertilize | 59.07 | Ac | 1,000 | $59,074 | |
| Mulch | 59.07 | Ac | 1,000 | $59,074 | |
| Fencing | | | | | |
| Barbed-wire Fence | 17,550 | LF | 2.50 | $43,875 | |
| Repository Fence | 2,950 | LF | 6.00 | $17,700 | |
| Subtotal | | | | $5,905,930 | |
| Construction Oversight | 15% | | | $885,890 | |
| Subtotal Capital Costs | | | | $6,791,820 | |
| Contingency | 10% | | | $679,182 | |
| TOTAL CAPITAL COSTS | | | | $7,471,002 | |
| POST CLOSURE MONITORING AND MAINTENANCE COSTS | | | | | |
| Inspections | 1 | /Year | 250 | $250 | |
| Sampling & Analysis | 4 | /Year | 200 | $800 | |
| Maintenance | 1 | L.S. | 1500 | $1,500 | |
| Subtotal | | | | $2,550 | |
| Contingency | 10% | | | $255 | |
| TOTAL ANNUAL O&M COST | | | | $2,805 | |
| TOTAL CAPITAL COSTS | | | | $7,471,002 | |
| PRESENT WORTH O&M COST | 30 | yrs @ | 10% | $26,442 | |

- Bottom Liner - A geosynthetic clay liner would be installed in the repository excavation. A 30-mil-thick, HDPE flexible membrane liner would overlay the geosynthetic clay liner.

- The mine waste would be deposited over the flexible membrane liner at an average depth of approximately 30 feet.

- Cap Liner - A geosynthetic clay liner would be installed overlaying the mine waste. A 20-mil-thick, HDPE flexible membrane liner would overlay the geosynthetic clay liner.

- Drainage Layer - A one-foot-thick layer of washed, coarse gravel would overlay the composite cap liner system. A geotextile filter fabric layer (to prevent potential clogging of the coarse gravel) would overlay the coarse gravel drainage layer.

  **Note:** To increase space for waste disposal (and possibly reduce construction costs), synthetic drainage layers (geotextile nets) can be used in lieu of granular drainage layers in constructing the repository.

- Vegetative Cover - A 1.5-foot thick layer of native soil would overlay the cap drainage layer. Cover soil would be obtained from unprocessed (i.e., overburden) placer tailings piles that were identified and sampled during the Phase I site characterization.

- Conventional plowing techniques would be adequate for preparing seed beds in the excavated source areas.

- The total surface area at the site requiring revegetation is approximately 59.07 acres, which includes the excavated source areas, repository cap and haul roads.

- The total length of required runon/runoff control diversion ditches is approximately 2,600 lineal feet.

- The total length of fencing required to enclose the excavated waste removal areas and the repository are 17,550 and 2,950 lineal feet, respectively.

<u>Screening Summary</u>

This alternative has been retained for detailed analysis due to its potential to cost effectively meet reclamation goals with a proven and uncomplicated technology.

#### 7.2.7.3 Alternative 7c: On-Site Disposal of Tailings in a Constructed Unlined Repository with a Multi-Layered Cap in the Goldsil Area

The reclamation strategy for Alternative 7c involves removing the mill tailings sources from the Drumlummon millsite, Drumlummon tailings area, Goldsil tailings area and the Upper, Middle and Lower Pond areas and disposing these wastes in a constructed unlined repository with a multi-layered cap (Figure 7-3). Assuming that the tailings volume was deposited in an area of approximately 12.6 acres, the total height of the repository would be approximately 100 feet, with a maximum waste thickness of approximately 70 feet, in order to achieve a 4:1 side slope design in the final cap.

Effectiveness - This alternative would effectively reduce contaminant mobility at the site by removing the highest risk solid media contaminant sources and disposing of the waste in a secure disposal facility. Consequently, the surface water erosion problems associated with the site are expected to be mitigated. Contaminant toxicity and volume would not be reduced, however, the waste would be rendered immobile in a structure and physical location protected from erosion problems. Infiltration of precipitation through the waste sources and resulting migration of contaminants through the vadose zone and groundwater would also be significantly reduced. Long-term monitoring and control programs would be established to ensure continued effectiveness.

This alternative is not expected to provide as high a degree of effectiveness as provided by a constructed repository which complies with all RCRA Subtitle C regulations (Alternative 7a) or a lined repository (Alternative 7b), however, this alternative may provide adequate protection at a significantly reduced cost. Although this alternative does not comply with EPA's Minimum Technology Guidance, the design may provide adequate environmental protection considering the chemical and physical characteristics of the mine waste in conjunction with the physical location of the repository site and the area's generally arid climate. EPA's HELP Model could be applied to the conceptual design to determine the relative effectiveness of the design and ultimately to determine the overall feasibility of the alternative and associated cost effectiveness.

Implementability - This alternative is both technically and administratively feasible. The construction steps required are considered standard and conventional construction practices. Key project components, such as the availability of equipment, materials, and construction expertise, are all present and would help ensure the timely implementation and successful execution of the proposed plan.

Cost Screening - The total present-worth cost for this alternative has been estimated at $5,793,759 which represents the reclamation of all of the mill tailings piles associated with Phases I and II of the Silver Creek Drainage Project. Table 7-14 presents the cost details associated with implementing this alternative. The total cost includes the present-worth value of 30 years of annual maintenance and monitoring costs in addition to capital costs.

The following assumptions were used to develop costs for this alternative:

- The total volume of waste material to be excavated and disposed in the repository is 611,820 cy.

- The mine waste would be deposited over the repository area at an average depth of approximately 30 feet.

- Cap Liner - A geosynthetic clay liner would be installed overlaying the mine waste.

- Drainage Layer - A one-foot-thick layer of washed, coarse gravel would overlay the composite cap liner system. A geotextile filter fabric layer (to prevent potential clogging of the coarse gravel) would overlay the coarse gravel drainage layer.

  **Note:** To increase space for waste disposal (and possibly reduce construction costs), synthetic drainage layers (geotextile nets) can be used in lieu of granular drainage layers in constructing the repository.

**Table 7-14. Preliminary Cost Estimate for Alternative 7c: On-Site Disposal of Tailings in a Constructed Unlined Repository with a Multi-Layered Cap in the Goldsil Area**

| Task | Quantity | Units | Unit $ | Cost $ | Comment |
|---|---|---|---|---|---|
| Mobilization, Bonding & Insurance | 1 | L.S. | 366,732 | $366,732 | 8% |
| Logistics | | | | | |
| Access Road | 12,500 | LF | 2.00 | $25,000 | |
| Site Clearing/Preparation | 38.99 | Ac | 2,000 | $77,975 | |
| Debris Removal and Onsite Disposal | 1 | LS | 30,000 | $30,000 | |
| Repository Construction | | | | | |
| Repository Base Preparation | 6,630 | CY | 3.00 | $19,890 | |
| Repository Base Grading | 14.94 | Ac | 2,000 | $29,880 | |
| Waste Load, Haul & Dump | | | | | |
| Drumlummon Millsite Tailings | 10,570 | CY | 6.90 | $72,933 | |
| Drumlummon Tailings | 59,780 | CY | 4.30 | $257,054 | |
| Goldsil Tailings | 491,970 | CY | 2.50 | $1,229,925 | |
| Upper Pond Tailings | 20,720 | CY | 4.20 | $87,024 | |
| Middle Pond Tailings | 11,110 | CY | 4.30 | $47,773 | |
| Lower Pond Tailings | 17,670 | CY | 4.40 | $77,748 | |
| Waste Grading and Compaction | 611,820 | CY | 2.00 | $1,223,640 | |
| Cap Construction | | | | | |
| Install Geotextile Cushion | 62,470 | SY | 3.00 | $187,410 | |
| Install Geosynthetic Clay Liner | 62,470 | SY | 4.50 | $281,115 | |
| Coarse Gravel (Cap Drain Layer) | 20,823 | CY | 20.00 | $416,460 | |
| Filter Fabric (geotextile) | 62,470 | SY | 3.00 | $187,410 | |
| Cover Soil | | | | | |
| BS-1 | 7,800 | CY | 4.30 | $33,540 | |
| BS-2 | 11,100 | CY | 4.10 | $45,510 | |
| PT35 | 10,800 | CY | 5.80 | $62,640 | |
| Other (near BS-2) | 1,535 | CY | 4.10 | $6,294 | |
| Water Diversion/Runon Controls | | | | | |
| Run-on Control Ditch | 2,600 | LF | 2.00 | $5,200 | |
| Revegetation | | | | | |
| Seed/Fertilize | 59.07 | Ac | 1,000 | $59,074 | |
| Mulch | 59.07 | Ac | 1,000 | $59,074 | |
| Fencing | | | | | |
| Barbed-wire Fence | 17,550 | LF | 2.50 | $43,875 | |
| Repository Fence | 2,950 | LF | 6.00 | $17,700 | |
| Subtotal | | | | $4,559,144 | |
| Construction Oversight | 15% | | | $683,872 | |
| Subtotal Capital Costs | | | | $5,243,015 | |
| Contingency | 10% | | | $524,302 | |
| TOTAL CAPITAL COSTS | | | | $5,767,317 | |
| POST CLOSURE MONITORING AND MAINTENANCE COSTS | | | | | |
| Inspections | 1 | /Year | 250 | $250 | |
| Sampling & Analysis | 4 | /Year | 200 | $800 | |
| Maintenance | 1 | L.S. | 1500 | $1,500 | |
| Subtotal | | | | $2,550 | |
| Contingency | 10% | | | $255 | |
| TOTAL ANNUAL O&M COST | | | | $2,805 | |
| TOTAL CAPITAL COSTS | | | | $5,767,317 | |
| PRESENT WORTH O&M COST | 30 | yrs @ | 10% | $26,442 | |
| **TOTAL PRESENT WORTH COST** | | | | $5,793,759 | |

- Vegetative Cover - A 1.5-foot thick layer of native soil would overlay the cap drainage layer. Cover soil would be obtained from unprocessed (i.e., overburden) placer tailings piles that were identified and sampled during the Phase I site characterization.

- Conventional plowing techniques would be adequate for preparing seed beds in the excavated source areas.

- The total surface area at the site requiring revegetation is approximately 59.07 acres, which includes the excavated source areas, repository cap and haul roads.

- The total length of required runon/runoff control diversion ditches is approximately 2,600 lineal feet.

- The total length of fencing required to enclose the excavated waste removal areas and the repository are 17,550 and 2,950 lineal feet, respectively.

<u>Screening Summary</u>

This alternative has been retained for detailed analysis due to its potential to cost effectively meet reclamation goals with a proven and uncomplicated technology.

### 7.2.8 Alternative 8. Partial On-Site Disposal of Waste Rock in the Drumlummon Mine Open Pits

The reclamation strategy for Alternative 8 involves removing waste rock from pile WR-4 and placing it in the open pits associated with the Drumlummon mine area. The primary purpose of this alternative is to mitigate the safety hazard associated with the steep highwalls in the open pits. There are a total of four open pit areas and the volumes and maximum highwall heights are summarized in Table 3-19. The maximum highwall height is approximately 100 feet in Pit #3.

This alternative would be designed to completely fill each pit area, thereby mitigating the exposed highwall. The combined volume of the four open pits is approximately 106,190 cubic yards. This would accommodate approximate 95 percent of waste rock pile WR-4. The remaining portion of WR-4 would be reclaimed in place.

The discharge from the main Drumlummon adit currently ponds in a marshy area above WR-4 and evaporates and/or infiltrates. As part of this alternative, the adit water would be piped down the steep slope to near the mill foundation, where it would be routed to an infiltration gallery.

<u>Effectiveness</u>: This alternative would effectively mitigate hazards associated with the open pit highwalls. Since no actual treatment of the contaminants would be conducted, the toxicity or volume of the wastes would not be reduced.

<u>Implementability</u>: This alternative is both technically and administratively feasible and can be implemented with available technology and equipment. Issues that would negatively affect the implementability of this alternative are access and topography. The existing access road to the open pit area is steep and narrow and would require significant improvements. A culvert or temporary bridge would be required where the existing road crosses Ottawa Gulch. Another issue that would need to be addressed is safety while the pit is being backfilled. The two

primary issues that would need to be addressed are the stability of the highwall and the stability of the pit floor. Spalling of the highwall during waste placement would constitute a serious safety hazard for workers. Similarly, the extent of mine workings below the pit floor are not known. Shallow workings below the pit floor could result in cave-ins, which would pose a serious safety hazard for workers. Geophysical investigations, such as ground penetrating radar, should be completed to evaluate the subsurface conditions prior to design and construction of the repository. Additionally, there are adit openings within the open pits. Bat habitat investigations would likely be required to determine if the open pit area repository would have significant adverse impacts on bat habitat. Another issue that must be addressed is the adit discharge above WR-4. The discharge from this adit currently ponds in a marshy area above WR-4 where it evaporates and/or infiltrates into the subsurface. If WR-4 is removed, the adit discharge would have to be accommodated in some manner.

Cost Screening: The total present-worth cost for Alternative 8 has been estimated at $1,368,203 which represents the reclamation of the majority of the waste rock associated with Phases I and II of the Silver Creek Drainage Project. Table 7-15 presents the cost details associated with implementing this alternative. The total cost includes the present-worth value of 30 years of annual maintenance and monitoring costs in addition to capital costs. The estimated cost is significantly greater than in-place containment of waste rock (Alternative 4). This estimated cost does not account for potential difficulties related to shallow mine workings below the pits, impacts to bat habitat in the open pits or provisions for adit water discharge at WR-4.

### 7.2.9 Alternative 9: Off-Site Disposal of Tailings in a Permitted Solid Waste Disposal Facility

The reclamation strategy for Alternative 9 involves removing the waste sources associated with Phases I and II of the Silver Creek Drainage Project which are the principal sources of concern (i.e., those sources which contribute the highest relative risks for surface water degradation) and disposing of these wastes in a Class II Municipal Solid Waste (MSW) Landfill. The sources to be disposed of in the landfill include the Drumlummon millsite tailings, Drumlummon tailings area, Goldsil tailings and the Upper, Middle and Lower Pond tailings areas. The nearest Class II MSW landfill is the Lewis and Clark County landfill, which is within 30 miles of the site.

In order for the waste to be accepted at a Class II MSW landfill, it would have to pass the Toxicity Characteristic Leaching Procedure (TCLP) test. The mill tailings were tested according to TCLP methods and the results indicate that no elements exceeded the regulatory levels for metal toxicity under the Resource Conservation and Recovery Act (RCRA) rules for hazardous waste classification.

Removal of the Drumlummon tailings would require the construction of a temporary diversion of Silver Creek while excavating the tailings. A considerable amount of heavy equipment would be necessary to efficiently implement this alternative. To load out the contaminated material, equipment requirements would include, but not be limited to, multiple bulldozers, front end loaders, and excavators. Haul trucks would be used to transport the material to the landfill facility. The field procedure would first involve constructing a single lane haul road with turnouts in the vicinity of the waste sources at the site to allow unobstructed access for haul trucks.

**Table 7-15. Preliminary Cost Estimate for Alternative 8: Partial On-Site Disposal of Waste Rock in the Drumlummon Mine Open Pits**

| Task | Quantity | Units | Unit $ | Cost $ | Comment |
|---|---|---|---|---|---|
| Mobilization, Bonding & Insurance | 1 | L.S. | 79,055 | $79,055 | 8% |
| Logistics | | | | | |
| Access Road | 11,000 | LF | 2.00 | $22,000 | |
| Site Clearing/Preparation | 3.56 | Ac | 2,000 | $7,118 | |
| Debris Removal and Onsite Disposal | 1 | LS | 5,000 | $5,000 | |
| Waste Load, Haul & Dump | | | | | |
| WR4 Excavation and Loading | 106,193 | CY | 2.00 | $212,386 | |
| Waste Hauling | 106,193 | CY | 3.90 | $414,153 | |
| Waste Rock Grading and Compaction | 106,193 | CY | 2.00 | $212,386 | |
| Cover Soil | | | | | |
| PT35 | 8,591 | CY | 9.10 | $78,174 | |
| Adit Water Diversion/Infiltration Gallery | 1 | LS | 10,000 | $10,000 | |
| Revegetation | | | | | |
| Seed/Fertilize | 7.11 | Ac | 1,000 | $7,109 | |
| Mulch | 7.11 | Ac | 1,000 | $7,109 | |
| Fencing | | | | | |
| Barbed-wire Fence | 5,100 | LF | 2.50 | $12,750 | |
| Subtotal | | | | $1,067,238 | |
| Construction Oversight | 15% | | | $160,086 | |
| Subtotal Capital Costs | | | | $1,227,324 | |
| Contingency | 10% | | | $122,732 | |
| TOTAL CAPITAL COSTS | | | | $1,350,056 | |
| POST CLOSURE MONITORING AND MAINTENANCE COSTS | | | | | |
| Inspections | 1 | /Year | 250 | $250 | |
| Maintenance | 1 | L.S. | 1500 | $1,500 | |
| Subtotal | | | | $1,750 | |
| Contingency | 10% | | | $175 | |
| TOTAL ANNUAL O&M COST | | | | $1,925 | |
| TOTAL CAPITAL COSTS | | | | $1,350,056 | |
| PRESENT WORTH O&M COST | 30 | yrs @ | 10% | $18,147 | |
| **TOTAL PRESENT WORTH COST** | | | | $1,368,203 | |

After the excavation and loadout are complete, the excavated areas would be revegetated. Cover/fill soil may be required in the excavated areas to level out and contour the areas to match the surrounding terrain. The seed beds would be prepared using conventional agricultural plowing. Seeding would take place during the fall of the year. The seed mixture and fertilizer would be applied simultaneously to the prepared seed beds via drill application. Disturbed surfaces are susceptible to erosion until vegetation is established; therefore, mulch would be applied to promote temporary protection of exposed erodible surfaces. Wheat or barley straw mulch (certified weed-free) would be applied over the excavated areas with a tow spreader or pneumatic spreader utilizing tucking/crimping as the anchoring mechanism.

<u>Effectiveness</u> - This alternative would effectively reduce contaminant mobility at the site by completely removing the highest risk solid media contaminant sources from the site. Contaminant toxicity and volume would not be reduced. Removal of wastes to a Class II MSW landfill facility provides long-term monitoring and control programs to ensure continued effectiveness. However, short-term risks of exposure to the contaminated material may occur during transport to the disposal facility.

<u>Implementability</u> - This alternative is technically feasible and would require standard construction practices. The administrative feasibility is questionable based on the waste disposal regulations, landfill permit requirements, multiple agency approval requirements, and the negative perception of the waste.

<u>Cost Screening</u> - The total present-worth cost for this alternative has been estimated at $45,718,677 which represents the excavation and removal of all of the tailings piles associated with Phases I and II of the Silver Creek Drainage Project. Table 7-16 presents the cost details associated with implementing this alternative. The total cost includes the present-worth value of 30 years of annual maintenance and monitoring costs in addition to capital costs.

The following assumptions were used to develop costs for this alternative:

- Based on the estimated volumes (611,820 cy), the total tonnage of waste material to be removed from the site has been estimated at 856,548 tons (1.4 tons/cy).

- The waste material would be hauled approximately 30 miles (one way) by truck to the landfill.

- Conventional plowing techniques would be adequate for preparing seed beds in the excavated areas.

- The total surface area at the site requiring revegetation is approximately 46.17 acres, which includes the excavated source areas and reclaimed haul roads.

- The total length of fencing required to enclose the excavated waste removal areas is 19,100 lineal feet.

<u>Screening Summary</u>

This alternative has not been retained for detailed evaluation because of the high cost and questionable implementability.

**Table 7-16. Preliminary Cost Estimate for Alternative 9: Off-Site Disposal of Tailings in a Permitted Solid Waste Disposal Facility**

| Task | Quantity | Units | Unit $ | Cost $ | Comment |
|---|---|---|---|---|---|
| Mobilization, Bonding & Insurance | 1 | LS | 2,676,067 | $2,676,067 | 8% |
| Logistics | | | | | |
| Access Road | 12,500 | LF | 2.00 | $25,000 | |
| Site Clearing/Preparation | 38.99 | Ac | 2,000 | $77,975 | |
| Debris Removal and Onsite Disposal | 1 | LS | 30,000 | $30,000 | |
| Waste Load, Haul & Dump | | | | | |
| Waste Excavation & Loading | 611,820 | CY | 2.00 | $1,223,640 | |
| Decon | 611,820 | CY | 0.25 | $152,955 | |
| Transportation | | | | | |
| Transportation to Disposal Facilty | 777,011 | CY | 15.00 | $11,655,171 | 27% Swell |
| DISPOSAL | | | | | |
| Disposal Charge | 856,548 | Ton | 22.50 | $19,272,330 | Disposal Facility Estimate |
| Special Handling | 856,548 | Ton | 1.02 | $873,679 | Disposal Facility Estimate |
| Revegetation | | | | | |
| Seed/Fertilize | 46.17 | Ac | 1,000 | $46,167 | |
| Mulch | 46.17 | Ac | 1,000 | $46,167 | |
| Fencing | | | | | |
| Barbed-wire Fence | 19,100 | LF | 2.50 | $47,750 | |
| Subtotal | | | | $36,126,901 | |
| Construction Oversight | 15% | | | $5,419,035 | |
| Subtotal Capital Costs | | | | $41,545,936 | |
| Contingency | 10% | | | $4,154,594 | |
| TOTAL CAPITAL COSTS | | | | $45,700,530 | |
| POST CLOSURE MONITORING AND MAINTENANCE COSTS | | | | | |
| Inspections | 1 | /Year | 250 | $250 | |
| Maintenance | 1 | L.S. | 1500 | $1,500 | |
| Subtotal | | | | $1,750 | |
| Contingency | 10% | | | $175 | |
| TOTAL ANNUAL O&M COST | | | | $1,925 | |
| TOTAL CAPITAL COSTS | | | | $45,700,530 | |
| PRESENT WORTH O&M COST | 30 | yrs @ | 10% | $18,147 | |
| **TOTAL PRESENT WORTH COST** | | | | $45,718,677 | |

### 7.2.10 Alternative 10: Off-Site Disposal of Tailings in a RCRA-Permitted Hazardous Waste Disposal Facility

The reclamation strategy for Alternative 10 involves removing the waste sources associated with Phases I and II of the Silver Creek Drainage Project which are the principal sources of concern (i.e., those sources which contribute the highest relative risks for surface water degradation) and disposing of these wastes in a RCRA-permitted hazardous waste disposal facility, pending profiling and acceptance of the waste at the disposal facility. The sources to be disposed of in the repository include the Drumlummon millsite tailings, Drumlummon tailings area, Goldsil tailings and the Upper, Middle and Lower Pond tailings areas. The two nearest RCRA-permitted hazardous waste disposal facilities with the capacity to dispose of the wastes are both located several hundred miles from the site (one facility is located in Idaho, the other in Oregon).

Removal of the Drumlummon tailings would require the construction of a temporary diversion of Silver Creek while excavating the tailings. A considerable amount of heavy equipment would be necessary to efficiently implement this alternative. To load out the contaminated material, equipment requirements would include, but not be limited to, multiple bulldozers, front end loaders, and excavators. Haul trucks would be used to transport the material to a local rail facility, where it would be transferred into gondola cars and shipped by rail to the RCRA facility. The field procedure would first involve constructing a single lane haul road with turnouts in the vicinity of the waste sources at the site to allow unobstructed access for haul trucks.

After the excavation and loadout are complete, the excavated areas would be revegetated. Cover/fill soil may be required in the excavated areas to level out and contour the areas to match the surrounding terrain. The seed beds would be prepared using conventional agricultural plowing. It is recommended that seeding take place during the fall of the year. The seed mixture and fertilizer would be applied simultaneously to the prepared seed beds via drill application. Disturbed surfaces are susceptible to erosion until vegetation is established; therefore, mulch would be applied to promote temporary protection of exposed erodible surfaces. Wheat or barley straw mulch (certified weed-free) would be applied over the excavated areas with a tow spreader or pneumatic spreader utilizing tucking/crimping as the anchoring mechanism.

<u>Effectiveness</u> - This alternative would effectively reduce contaminant mobility at the site by removing the contaminant sources; consequently, the site problems are expected to be permanently corrected. Contaminant toxicity and volume would not be reduced, but would be permanently transferred to a different physical location. Disposal at a RCRA-permitted facility establishes long-term monitoring and control programs to enhance continued effectiveness. However, short-term risks of exposure to the contaminated material would occur during transport to the disposal facility.

<u>Implementability</u> - This alternative is both technically and administratively feasible. The construction steps required (excavation and loadout) are considered standard construction practices. Key project components, such as the availability of equipment, materials, and a RCRA facility with adequate capacity, are present and would allow for the timely implementation and successful execution of the proposed plan.

<u>Cost Screening</u> - The total present-worth cost for this alternative has been estimated at $141,285,185 which represents the reclamation of all of the tailings piles associated with

Phases I and II of the Silver Creek Drainage Project. Table 7-17 presents the cost details associated with implementing this alternative. The total cost includes the present-worth value of 30 years of annual maintenance and monitoring costs in addition to capital costs.

The following assumptions were used to develop costs for this alternative:

- Based on the estimated volumes (611,820 cy), the total tonnage of waste material to be removed from the site has been estimated at 856,548 tons (1.4 tons/cy).
- The waste material would be hauled 22 miles (one way) by truck to a suitable transfer area, where it would be loaded out and shipped by rail.
- Conventional plowing techniques would be adequate for preparing seed beds in the excavated areas.
- The total surface area at the site requiring revegetation is approximately 46.17 acres, which includes the excavated source areas and reclaimed haul roads.
- The total length of fencing required to enclose the excavated waste removal areas is 19,100 lineal feet.

Screening Summary

This alternative has not been retained for detailed evaluation, because of the extremely high cost.

## 7.3 ALTERNATIVES SCREENING SUMMARY

Table 7-18 summarizes the findings of the alternatives screening process. Costs generated and summarized in Table 7-18 are present-worth values which include construction costs, as well as operation/monitoring and maintenance costs, for a 30-year period. These cost estimates are order-of-magnitude estimates, generated for planning purposes. Cost estimates will be refined during the detailed analysis of retained alternatives based on slight customizations to some alternatives.

Alternatives 5a, 5b, 5c, 6a, 6b, and 6c have been screened out because of cost. Alternative 5 and Alternative 6 scenarios address only a portion (Drumlummon and Goldsil tailings for Alternative 5 and Upper, Middle and Lower Pond tailings for Alternative 6) of the total tailings volume. To address all of the tailings sources, both Alternative 5 and Alternative 6 would need to be implemented jointly. For example, implementing Alternative 5c and 6c would place all of the tailings sources into two repositories. However, the joint cost for Alternatives 5c and 6c is $6,509,956, which is greater than the cost for placing the same tailings waste sources into a single repository under Alternative 7c. The same is true for the combinations of Alternative 5a and 6a compared to 7a and Alternatives 5b and 6b compared to 7b. Therefore, all combinations of Alternatives 5 and 6 have been screened out.

Alternative 7a has been screened out because of the high cost and a similar degree of effectiveness can be obtained from Alternative 7b at a significantly lower cost. Alternative 9 has been screened out because of the high cost and questionable implementability. Alternative 10 has been screened out because of the extremely high cost.

**Table 7-17. Preliminary Cost Estimate for Alternative 10: Off-Site Disposal of Tailings in a RCRA-Permitted Hazardous Waste Disposal Facility**

| Task | Quantity | Units | Unit $ | Cost $ | Comment |
|---|---|---|---|---|---|
| Mobilization, Bonding & Insurance | 1 | L.S. | 8,272,115 | $8,272,115 | 8% |
| Logistics | | | | | |
| Access Road | 12,500 | LF | 2.00 | $25,000 | |
| Site Clearing/Preparation | 38.99 | Ac | 2,000 | $77,975 | |
| Debris Removal and Onsite Disposal | 1 | LS | 30,000 | $30,000 | |
| Waste Load, Haul & Dump | | | | | |
| Waste Excavation & Loading | 611,820 | CY | 2 | $1,223,640 | |
| Waste Hauling to Rail Transfer | 777,011 | CY | 13 | $10,101,143 | 27% Swell |
| Decon | 611,820 | CY | 0.25 | $152,955 | |
| Transportation | | | | | |
| Transportation to Disposal Facilty | 856,548 | Ton | 37 | $31,692,276 | Rail Shipment Estimate |
| DISPOSAL | | | | | |
| Profiling Charge | 1 | LS | 200.00 | $200 | Disp. Facility Estimate |
| Profiling Charge Credit | 1 | LS | -200.00 | ($200) | Disp. Facility Estimate |
| Disposal Charge | 856,548 | Ton | 45.00 | $38,544,660 | Disp. Facility Estimate |
| Tax Charge | 856,548 | Ton | 25.00 | $21,413,700 | Disp. Facility Estimate |
| Revegetation | | | | | |
| Seed/Fertilize | 46.17 | Ac | 1,000 | $46,167 | |
| Mulch | 46.17 | Ac | 1,000 | $46,167 | |
| Fencing | | | | | |
| Barbed-wire Fence | 19,100 | LF | 2.50 | $47,750 | |
| Subtotal | | | | $111,673,548 | |
| Construction Oversight | 15% | | | $16,751,032 | |
| Subtotal Capital Costs | | | | $128,424,580 | |
| Contingency | 10% | | | $12,842,458 | |
| TOTAL CAPITAL COSTS | | | | $141,267,038 | |
| POST CLOSURE MONITORING AND MAINTENANCE COSTS | | | | | |
| Inspections | 1 | /Year | 250 | $250 | |
| Maintenance | 1 | L.S. | 1500 | $1,500 | |
| Subtotal | | | | $1,750 | |
| Contingency | 10% | | | $175 | |
| TOTAL ANNUAL O&M COST | | | | $1,925 | |
| TOTAL CAPITAL COSTS | | | | $141,267,038 | |
| PRESENT WORTH O&M COST | 30 | yrs @ | 10% | $18,147 | |
| **TOTAL PRESENT WORTH COST** | | | | $141,285,185 | |

## TABLE 7-18 ALTERNATIVES SCREENING SUMMARY

| ALTERNATIVE DESCRIPTION | EFFECTIVE | IMPLEMENTABLE | COST ESTIMATE | RETAINED FOR DETAILED ANALYSIS |
|---|---|---|---|---|
| 1: No Action | NA | NA | $0 | Yes |
| 2: Institutional Controls | Low | Yes | $701,345 | No |
| 3: Consolidation/In-Place Containment of Tailings | Medium | Yes | $1,388,221 | Yes |
| 4: In-Place Containment of Waste Rock | Medium | Yes | $177,343 | Yes |
| 5a: Partial On-Site Disposal of Tailings in a Constructed RCRA Subtitle C Repository in the Goldsil Area | High | Yes | $9,365,051 | No |
| 5b: Partial On-Site Disposal of Tailings in a Constructed Modified RCRA Repository in the Goldsil Area | High | Yes | $6,824,642 | No |
| 5c: Partial On-Site Disposal of Tailings in a Constructed Unlined Repository with a Multi-Layered Cap in the Goldsil Area | Medium-High | Yes | $5,681,949 | No |
| 6a: Partial On-Site Disposal of Tailings in a Constructed RCRA Subtitle C Repository in the Lower Pond Area | High | Yes | $1,665,659 | No |
| 6b: Partial On-Site Disposal of Tailings in a Constructed Modified RCRA Repository in the Lower Pond Area | High | Yes | $1,085,994 | No |
| 6c: Partial On-Site Disposal of Tailings in a Constructed Unlined Repository with a Multi-Layered Cap in the Lower Pond Area | Medium-High | Yes | $828,007 | No |
| 7a: On-Site Disposal of Tailings in a Constructed RCRA Subtitle C Repository in the Goldsil Area | High | Yes | $10,182,511 | No |
| 7b: On-Site Disposal of Tailings in a Constructed Modified RCRA Repository in the Goldsil Area | High | Yes | $7,497,444 | Yes |
| 7c: On-Site Disposal of Tailings in a Constructed Unlined Repository with a Multi-Layered Cap in the Goldsil Area | Medium-High | Yes | $5,793,759 | Yes |
| 8: Partial On-Site Disposal of Waste Rock in the Drumlummon Mine Open Pits | Medium | Yes | $1,368,203 | Yes |
| 9: Off-Site Disposal of Tailings in a Permitted Solid Waste Disposal Facility | High | Questionable | $45,718,677 | No |
| 10: Off-Site Disposal of Tailings in a RCRA-Permitted Hazardous Waste Disposal Facility | High | Yes | $141,285,185 | No |

## 7.4 ALTERNATIVES REFINEMENT PROCESS

The alternatives development and screening process resulted in a variety of reclamation alternatives for the Phases I and II of the Silver Creek Drainage Project. A total of 16 reclamation alternatives, including the no action alternative, were preliminarily developed, presented, and evaluated in Section 7.2.

Alternatives 7b and 7c have been modified to substitute geocomposite drainage layers for the gravel drainage layers. Geocomposite drainage layers will provide similar effectiveness for a lower cost.

The following alternatives have been retained for detailed analysis:

- Alternative 1: No Action,
- Alternative 3: Consolidation/In-Place Containment of Tailings,
- Alternative 4: In-Place Containment of Waste Rock,
- Alternative 7b: On-Site Disposal of Tailings in a Constructed Modified RCRA Repository in the Goldsil Area,
- Alternative 7c: On-Site Disposal of Tailings in a Constructed Unlined Repository with a Multi-Layered Cap in the Goldsil Area, and
- Alternative 8: Partial On-Site Disposal of Waste Rock in the Drumlummon Mine Open Pits

# 8.0 DETAILED ANALYSIS OF RECLAMATION ALTERNATIVES

The purpose of the detailed analysis is to evaluate, in further detail, reclamation alternatives for their effectiveness, implementability, and cost to control and reduce the toxicity, mobility, and/or volume of contaminated mine/mill wastes associated with Phases I and II of the Silver Creek Drainage Project. Only those reclamation alternatives which were retained after the preliminary evaluation in Section 7.2 and were further screened in the Section 7.4 alternative refinement process are included. Each reclamation alternative currently being considered for implementation for Phases I and II of the Silver Creek Drainage Project is classifiable as an interim or removal action and is not a complete reclamation action. The reclamation alternatives are applicable to the contaminated solid media only; no reclamation alternatives have been developed or evaluated for active treatment of groundwater, surface water, or off-site stream sediments. The rationale for not directly developing remedial alternatives for these environmental media was based primarily on the presumption that reclaiming the contaminant source(s) will subsequently reduce or eliminate the problems associated with surface water, groundwater, and off-site stream sediments at a significantly reduced cost.

As required by the CERCLA and the NCP, reclamation alternatives that were retained after the initial evaluation and screening have to be evaluated individually against the following criteria:

- overall protection of human health and the environment;
- compliance with ARARs;
- long-term effectiveness and permanence;
- reduction of toxicity, mobility, or volume through treatment;
- short-term effectiveness;
- implementability; and
- cost.

Supporting agency acceptance and community acceptance are additional criteria that will be addressed after DEQ-MWCB and the public have a chance to review the evaluations presented. The analysis criteria have been used to address the CERCLA requirements and considerations with EPA guidance (EPA, 1988a), as well as additional technical and policy considerations. These analysis criteria serve as the basis for conducting the detailed analysis and subsequently selecting the preferred reclamation alternative. The criteria listed above are categorized into three groups, each with distinct functions in selecting the preferred alternative. These groups include:

- Threshold Criteria - overall protection of human health and the environment and compliance with ARARs;
- Primary Balancing Criteria - long-term effectiveness and permanence; reduction of toxicity, mobility, or volume through treatment; short-term effectiveness; implementability; and cost; and
- Modifying Criteria - state and community acceptance.

Overall protection of human health and the environment and compliance with applicable or relevant and appropriate requirements are threshold criteria that must be satisfied for an alternative to be eligible for selection. Long-term effectiveness and permanence; reduction of toxicity, mobility, or volume; short-term effectiveness; implementability; and cost are the primary balancing factors used to weigh major trade-offs between alternative hazardous management strategies. State and community acceptance are modifying considerations that are formally considered after public comment is received on the proposed plan and the Expanded EE/CA report (Federal Register, No. 245, 51394-50509, December 1988). Each of these criteria is briefly described in the following paragraphs.

Compliance with ARARs criteria assesses how each alternative complies with applicable or relevant and appropriate standards, criteria, advisories, or other guidelines. Waivers will be identified, if necessary. The following factors will be addressed for each alternative during the detailed analysis of ARARs:

- compliance with chemical-specific ARARs;
- compliance with action-specific ARARs;
- compliance with location-specific ARARs; and
- compliance with appropriate criteria, advisories, and guidelines.

Long-term effectiveness and permanence evaluates the alternative's effectiveness in protecting human health and the environment after response objectives have been met. The following components of the criteria will be addressed for each alternative:

- magnitude of remaining risk;
- adequacy of controls; and
- reliability of controls.

The reduction of toxicity, mobility, or volume assessment evaluates anticipated performance of the specific treatment technologies. This evaluation focuses on the following specific factors for a particular reclamation alternative:

- the treatment process, the remedies they will employ, and the materials they will treat;
- the amount of hazardous materials that will be destroyed or treated, including how principal threat(s) will be addressed;
- the degree of expected reduction in toxicity, mobility, or volume measured as a percentage of reduction (or order of magnitude);
- degree to which the treatment will be irreversible; and
- the type and quantity of treatment residuals that will remain following treatment.

Short-term effectiveness evaluates an alternative's effectiveness in protecting human health and the environment during the construction and implementation period until the response objectives are met. Factors that will be considered under this criteria include:

- protection of the surrounding community during reclamation actions;
- protection of on-site workers during reclamation actions;
- protection from environmental impacts; and
- time until removal response objectives are achieved.

Implementability evaluates the technical and administrative feasibility of alternatives and the availability of required resources. Analysis of this criterion will include the following factors and subfactors:

Technical Feasibility

- construction and operation;
- reliability of technology;
- ease of undertaking additional remedial action; and
- monitoring considerations.

Administrative Feasibility

- RCRA disposal restrictions;
- institutional controls; and
- permitting requirements.

Availability of Services and Materials

- adequate off-site treatment, storage capacity, and disposal service;
- necessary equipment and specialists and provisions to ensure any necessary additional resources;
- timing of the availability of technologies under consideration; and
- services and materials.

The cost assessment evaluates the capital and operation and maintenance (O&M) costs of each alternative. A present-worth analysis based on a 10-percent inflation rate and a maximum design life of 30 years will be used to compare alternatives. Cost screening consists of developing conservative, order-of-magnitude cost estimates based on similar sets of site-specific assumptions. Cost estimates for each alternative will consider the following factors:

Capital Costs

- construction costs;
- equipment costs;
- land and site development costs;
- disposal costs;
- engineering design;
- legal fees, license, and permit costs;
- startup and troubleshooting costs; and
- contingency allowances.

Annual Costs

- operating labor;
- maintenance materials and labor;
- auxiliary materials and energy;
- disposal residues;
- purchased services (i.e., sampling costs, laboratory fees, professional fees);
- administrative costs;
- insurance, taxes, and licensing;
- maintenance reserve and contingency funds;
- rehabilitation costs; and
- periodic site reviews.

State acceptance will evaluate the technical and administrative issues and concerns the state may have regarding each of the alternatives. State acceptance will also focus on legal issues and compliance with state statutes and regulations. Community acceptance will incorporate public concerns into the analyses of the alternatives.

The final step of this process is to conduct a comparative analysis of the alternatives. The analysis will include a discussion of the alternative's relative strengths and weaknesses with respect to each of the criteria and how reasonable key uncertainties could change expectations of their relative performance.

Once completed, this evaluation will be used to select the preferred alternative(s). The selection of the preferred alternative(s) will be documented in a Record of Decision. Public meetings to present the alternatives will be conducted and significant oral and written comments will be addressed in writing.

## 8.1 ALTERNATIVE 1: NO ACTION

The no action alternative means that no reclamation is done at the site to control contaminant migration or to reduce toxicity or volume. This option would require no further reclamation investigation or monitoring action at the site. The no action response is generally used as a baseline against which other reclamation options can be compared. This alternative has been retained for further evaluation as suggested by the NCP.

### 8.1.1 Overall Protection of Human Health and the Environment

The no action alternative provides no control of exposure to the contaminated materials and no reduction in risk to human health or the environment. It allows for the continued migration of contaminants and further degradation of water and air.

Protection of human health would not be achieved under the no action alternative. Prevention of direct human exposure via the pathway of concern would not be achieved. Ingestion of mercury via fish ingestion under a recreational exposure scenario would not be reduced. Protection of the environment would also not be achieved under the no action alternative. Prevention of ecological exposures via exposure to sediment and soil sources would not be achieved: deer exposure to lead via ingestion of tailings salts would not be reduced; plant phytotoxicity to copper and zinc would not be reduced; acute aquatic life exposures to cadmium, copper and zinc in surface water would not be reduced, and aquatic life exposures to lead (and mercury, although no mercury standards exist) in sediment would not be reduced. A risk reduction achievement matrix for the various pathways and contaminants, identified in the baseline human health risk assessment and the ecological risk assessment, is shown in Table 8-1.

### 8.1.2 Compliance with ARARs

A comprehensive list of federal and state Applicable or Relevant and Appropriate Requirements (ARARs) has been developed for the Phases I and II of the Silver Creek Drainage Project and is summarized in Section 4.0. ARARs are divided into contaminant-specific, location-specific, and

**Table 8-1. Risk Reduction Achievement Matrix for Alternative 1**

| Exposure Pathway | Risk Level | Antimony | | Cadmium | | Copper | | Cyanide | | Lead | | Mercury | | Silver | | Zinc | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal |
| Human Risk: | | | | | | | | | | | | | | | | | |
| Water Ingestion/Fish | HQ=1 | 36.7 | NA | 66.5 | Yes | 996 | Yes | 10200 | Yes | 165 | Yes | 0.294 | No | NA | | 34400 | Yes |
| Ingestion Pathway (ug/l) | Carc. 1E-06 | | | NA | | | | | | | | | | | | | |
| Soil Ingestion/Dust | HQ=1 | 586 | Yes | 1750 | Yes | 54200 | Yes | 11100 | Yes | 2200 | Yes | 440 | Yes | NA | | 440000 | Yes |
| Inhalation Pathway (mg/Kg) | Carc. 1E-06 | | | 38.9 | Yes | | | | | | | | | | | | |
| Ecological Risk Scenario: | EQ=1 | | | | | | | | | | | | | | | | |
| Deer - Tailings Salt Ingestion (mg/Kg) | LOAEL | NA | | 880 | Yes | NA | | NA | | 314 | No | NA | | NA | | NA | |
| Plant Phytotoxicity - Soil (mg/Kg) | Max Phytotox. | NA | | 8 | Yes | 125 | No | NA | | 400 | Yes | NA | | NA | | 400 | No |
| Aquatic Life - Water (ug/l) | AALS | NA | | 2.1 | No | 14 | No | 22 | Yes | 81.6 | Yes | 1.7 | Yes | 4.1 | NA | 120 | No |
| Aquatic Life - Sediment (ug/l) | PSQC | NA | | 9 | Yes | 390 | Yes | NA | | 110 | No | NA | | NA | | 270 | Yes |

Notes: NA - Not Applicable
LOAEL - Lower observed adverse effect level
AALS - Freshwater Acute Aquatic Life Standards (DEQ, 2002). Hardness = 100 mg/l CaCO3 for hardness dependent elements.
PSQC - Proposed Sediment Quality Criteria

**Table 8-2. Water Quality ARARs Attainment for Alternative 1**

| | Antimony | | Cadmium | | Copper | | Cyanide | | Lead | | Mercury | | Silver | | Zinc | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal |
| Drinking Water MCL/HHS | 6 | NA | 5 | No | 1300 | Yes | 200 | Yes | 15 | No | 0.05 | No | 100 | NA | 2000 | Yes |
| Aquatic Life CALS | NA | | 0.27 | No | 9.3 | No | 5.2 | No | 3.2 | No | 0.91 | Yes | NA | | 120 | No |

HHS - Human Health Standards for Surface Water (DEQ, 2002)
MCL - Maximum Contaminant Level Drinking Water Regulations and Health Advisories, (EPA, 1993)
CALS - Freshwater Chronic Aquatic Life Standards (DEQ, 2002)
Water concentrations in ug/L.
CALS based on water hardness of 100 mg/L.

action-specific requirements. Contaminant-specific ARARs are waste-related requirements which specify how a waste must be managed, treated, and/or disposed depending upon the classification of the waste material. Location-specific ARARs specify how the remedial activities must take place depending upon where the wastes are physically located (i.e., in a stream or floodplain, wilderness area, or sensitive environment, etc.), or where the wastes may be treated or disposed, and what authorizations (permits) may be required. Action-specific ARARs do not determine the preferred reclamation alternative, but indicate how the selected alternative must be achieved.

Under the no action alternative, no contaminated materials would be treated, removed, or actively managed. Consequently, the no action alternative would not satisfy any federal or state contaminant-specific ARARs. Water quality ARARs not attained in surface water are listed in Table 8-2. Location and action specific ARARs are not applicable.

### 8.1.3 Long-Term Effectiveness and Permanence

Toxicity, mobility, and volume of contaminants would not be reduced under the no action alternative. Also, protection of human health and the environment would not be achieved under this alternative. No control measures would be completed on the waste sources identified as causing environmental impacts at the site. The no action alternative would not address surface water impacts that have been identified nor would it provide controls on contaminant migration via direct contact or particulate emissions.

### 8.1.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

The no action alternative would provide no reduction in toxicity, mobility, or volume of the contaminated materials.

### 8.1.5 Short-Term Effectiveness

Short-term effectiveness is not applicable.

### 8.1.6 Implementability

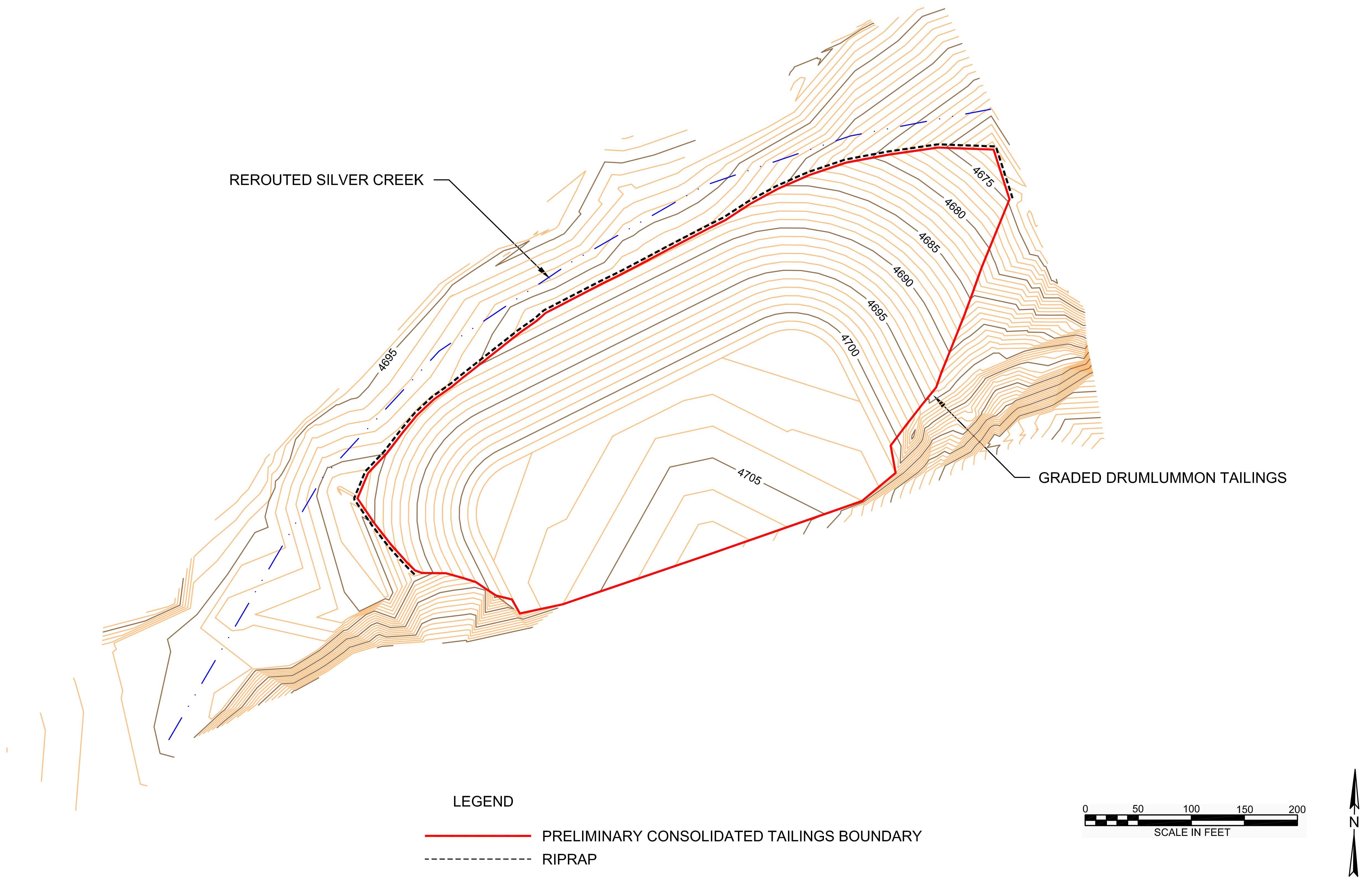
Technical and administrative feasibility evaluation criteria do not apply to this alternative.

### 8.1.7 Costs

No capital or operating costs would be incurred under this alternative.

## 8.2 ALTERNATIVE 3: CONSOLIDATION/IN-PLACE CONTAINMENT

Under Alternative 3, the Drumlummon millsite tailings and the Upper, Middle and Lower Pond tailings would be the left in place and capped with a one-foot thick layer of cover soil. The northern portion of the Drumlummon tailings would be excavated from the stream drainage and consolidated with tailings in the southern portion of the drainage. Figure 8-1 shows the

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| | | | | SCALE: AS SHOWN | FILENAME: A1348DT-Alt3.dwg | |

MONTANA DEQ/MINE WASTE CLEANUP BUREAU
SILVER CREEK DRAINAGE PROJECT
LEWIS & CLARK COUNT, MONTANA

**Olympus Technical Services, Inc.**

PRELIMINARY DESIGN OF ALTERNATIVE 3 FOR THE CONSOLIDATED DRUMLUMMON TAILINGS

FIGURE 8-1

preliminary design for the Drumlummon tailings area consolidation and in-place containment. The tailings would be graded to achieve a 3:1 or flatter slope. After removal of the tailings, Silver Creek would be reconstructed to convey the discharge from the estimated 100-year flood and protect the graded waste pile.

Figure 8-2 shows the preliminary design for the Goldsil tailings area consolidation and in-place containment. The main Goldsil tailings would be graded to reduce the slope along the northern edge to 3:1 or flatter and tailings from the lined pond area and the former Goldsil mill would be consolidated with the main Goldsil tailings. The toe of the Goldsil tailings slope would be armored with riprap to protect it from scour by Silver Creek. The consolidated Drumlummon and Goldsil tailings areas would each be capped with one foot of cover soil and revegetated.

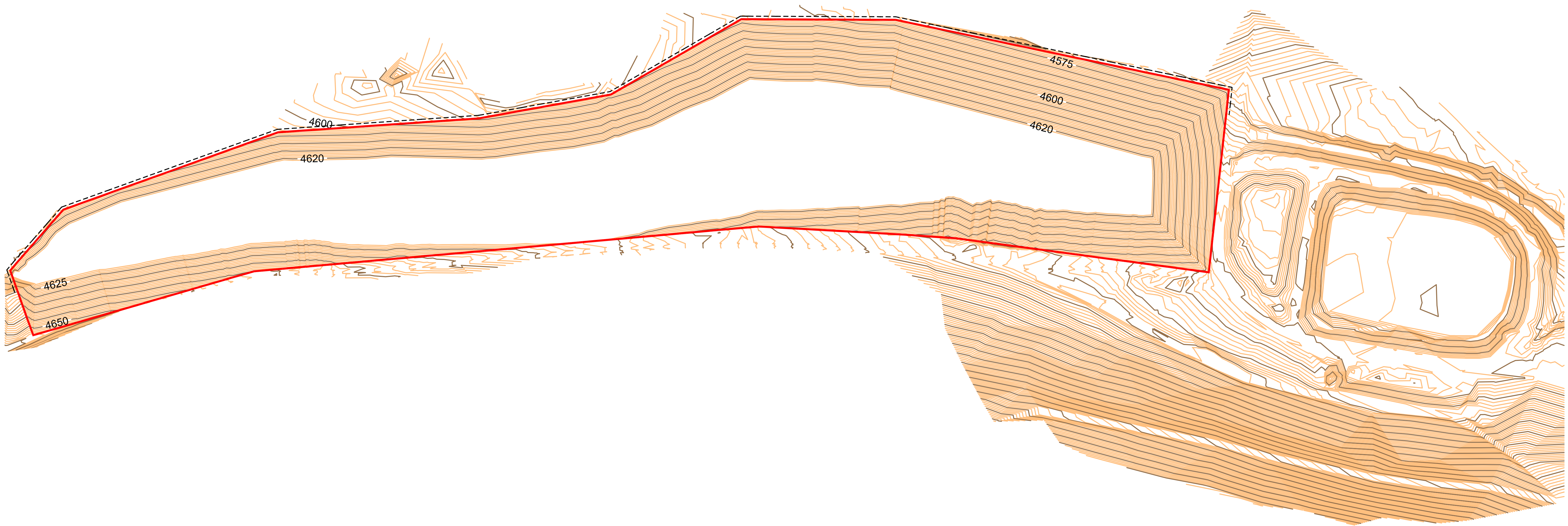
Acid base accounting data indicate that the overall acid generating potential of the tailings is low (Section 3.2.4), which supports in-place containment. Water runon to the consolidated and reclaimed tailings and waste rock piles would be controlled by diversion ditches on the upgradient side of each pile. The soil cap would be fertilized and seeded with an appropriate mix for establishing vegetation and a certified weed free straw mulch would applied. The reclaimed waste piles would be fenced off with 4-strand, barbed-wire fence to control access in order to establish vegetation without interference by livestock.

The U.S. EPA Hydrologic Evaluation of Landfill Performance (HELP) model was used to simulate the in-place containment scenario of the Goldsil tailings. The Goldsil tailings were selected for modeling because they represent the largest single source of tailings and are also among the most elevated metals chemistry of the sources evaluated in Phases I and II. Based on representative soil properties for the one-foot of cover soil and an average of 17.4 feet of tailings, the predicted infiltration of water through the tailings is an average of 0.100 inches per year over a 30-year period. This is equivalent to 0.63 percent of the average annual precipitation of 15.94 inches. An average of 14.68 inches of water per year is predicted to be lost through evapotranspiration, which is equivalent to 92.08 percent of the average annual precipitation. Surface water runoff accounts for a loss of 1.06 inches per year or 6.67 percent of precipitation. The remaining 0.62 percent of precipitation is accounted for by changes in water storage in the cover soil and tailings layers. The 0.100 inches of percolation per year over the 17.49 acre area encompassing the consolidated Goldsil tailings piles that is predicted to percolate from the tailings is equal to a discharge rate of 130 gallons per day over a 30 year period.

### 8.2.1 Overall Protection of Human Health and the Environment

The consolidation/in-place containment alternative provides control of direct exposure to the contaminated materials and reduction in risk to human health and the environment. It prevents further erosion and migration of contaminants from source areas.

Consolidating and capping the waste piles would prevent exposure by direct contact. Cleanup below background concentrations is not considered achievable. Ingestion exposure to mercury via ingestion of contaminated fish is expected to eventually be reduced to below risk-based cleanup goals since further erosion of contaminated sediments into Silver Creek would be prevented. Mercury exposure via the fish ingestion pathway would be reduced to levels consistent with background water quality. Cleanup below background concentrations is not considered achievable.




LEGEND

PRELIMINARY CONSOLIDATED TAILINGS BOUNDARY

RIPRAP

| NO. | REVISION DESCRIPTION | BY | DATE |
|---|---|---|---|

| | | |
|---|---|---|
| DESIGN: | DRAWN: KSR | CHECKED: CRS |
| APPROVED: | DATE: 3/2003 | JOB NO: A1348 |
| SCALE: AS SHOWN | FILENAME: A1348GT-Alt3.dwg | |

MONTANA DEQ/MINE WASTE CLEANUP BUREAU
SILVER CREEK DRAINAGE PROJECT
LEWIS & CLARK COUNTY, MONTANA

**Olympus Technical Services, Inc.**

PRELIMINARY DESIGN OF ALTERNATIVE 3 FOR THE CONSOLIDATED GOLDSIL TAILINGS

FIGURE 8-2

Protection of the environment would generally be achieved under the consolidation/in-place containment alternative. Prevention of ecological exposures via exposure to water, sediment, and soil sources would be achieved to the extent practicable: deer exposure to lead via ingestion of tailings salts; plant phytotoxicity to copper and zinc; acute exposure of aquatic life to copper and zinc via surface water; and aquatic life exposure to lead via sediment would be reduced to risk-based cleanup levels. Since the waste sources would be removed from Silver Creek, cadmium, copper and zinc concentrations in the surface water would be reduced to levels consistent with background, however, cadmium concentrations may not be reduced below acute aquatic life standards. Similarly, lead (and mercury, although no mercury standard exists) concentrations in stream sediments would be reduced as existing sediments are either diluted by mixing with natural sediment or through bedload dispersion downstream. A risk reduction achievement matrix for the various pathways and contaminants, identified in the baseline human health risk assessment and the ecological risk assessment, is shown in Table 8-3.

### 8.2.2 Compliance with ARARs

With the exception of cadmium, lead and mercury, contaminant-specific ARARs are expected to be met when implementing this alternative. Table 8-4 shows that drinking water MCLs and/or HHS for cadmium, copper, cyanide, and zinc and ambient water quality criteria for copper, cyanide, mercury, and zinc are achieved in Silver Creek under this alternative. This is based on the assumption that elevated levels of these contaminants in surface water are attributed to the presence of contaminated sediments in Silver Creek and that sediments will eventually be sufficiently diluted such that they do not cause significant metals loading to Silver Creek. Implementation of this alternative will prevent further erosion of contaminated sediments into Silver Creek. Drinking water MCLs and/or HHS for lead and mercury and ambient water quality criteria for cadmium and lead are not achieved under this alternative. Background water quality exceeds MCLs and/or HHS for lead and mercury and exceeds CALS for cadmium and lead. However, cleanup below background concentrations is not considered achievable.

Implementation of this alternative is also expected to satisfy air quality regulations because the soil cap and vegetation cover would stabilize the contaminant sources and inhibit fugitive emissions. The tailings have the highest potential for fugitive emissions based on grain size.

Location-specific ARARs are expected to be met in the implementation of this alternative. Contacts with the appropriate agencies and acquisition of required permits related to streambeds, floodplains, and archaeological/paleontological resources would be completed.

Action-specific ARARs are expected to be met including the hydrological regulations contained in the Strip and Underground Mine Reclamation Act. The tailings materials of concern are derived from the beneficiation and extraction of ores and are therefore exempt from federal regulation under the Resource Conservation and Recovery Act (RCRA), 42 U.S.C. 6921 (b) (3) (A)(iii)(1994) as a hazardous waste. Mine and mill wastes are also excluded under the Montana Solid Waste Management Act (75-10-214 (1)(b) MCA. Any temporary stream diversions for construction activities will require coordination with the Montana Department of Fish, Wildlife, and Parks, The U.S. Army Corps of Engineers, the Montana Department of Natural Resources and Conservation, and the Lewis & Clark County Conservation District. Revegetation requirements contained in the Surface Mining and Control Reclamation Act would be met. State

**Table 8-3. Risk Reduction Achievement Matrix for Alternative 3**

| Exposure Pathway | Risk Level | Antimony | | Cadmium | | Copper | | Cyanide | | Lead | | Mercury | | Silver | | Zinc | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal |
| Human Risk: | | | | | | | | | | | | | | | | | |
| Water Ingestion/Fish | HQ=1 | 36.7 | NA | 66.5 | Yes | 996 | Yes | 10200 | Yes | 165 | Yes | 0.294 | Yes | NA | | 34400 | Yes |
| Ingestion Pathway (ug/l) | Carc. 1E-06 | | | NA | | | | | | | | | | | | | |
| Soil Ingestion/Dust | HQ=1 | 586 | Yes | 1750 | Yes | 54200 | Yes | 11100 | Yes | 2200 | Yes | 440 | Yes | NA | | 440000 | Yes |
| Inhalation Pathway (mg/Kg) | Carc. 1E-06 | | | 38.9 | Yes | | | | | | | | | | | | |
| Ecological Risk Scenario: | EQ=1 | | | | | | | | | | | | | | | | |
| Deer - Tailings Salt Ingestion (mg/Kg) | LOAEL | NA | | 880 | Yes | NA | | NA | | 314 | Yes | NA | | NA | | NA | |
| Plant Phytotoxicity - Soil (mg/Kg) | Max Phytotox. | NA | | 8 | Yes | 125 | Yes | NA | | 400 | Yes | NA | | NA | | 400 | Yes |
| Aquatic Life - Water (ug/l) | AALS | NA | | 2.1 | No | 14 | Yes | 22 | Yes | 81.6 | Yes | 1.7 | Yes | 4.1 | NA | 120 | Yes |
| Aquatic Life - Sediment (ug/l) | PSQC | NA | | 9 | Yes | 390 | Yes | NA | | 110 | Yes | NA | | NA | | 270 | Yes |

Notes: NA - Not Applicable
LOAEL - Lower observed adverse effect level
AALS - Freshwater Acute Aquatic Life Standards (DEQ, 2002). Hardness = 100 mg/l CaCO3 for hardness dependent elements.
PSQC - Proposed Sediment Quality Criteria

**Table 8-4. Water Quality ARARs Attainment for Alternative 3**

| | Antimony | | Cadmium | | Copper | | Cyanide | | Lead | | Mercury | | Silver | | Zinc | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal |
| Drinking Water MCL/HHS | 6 | NA | 5 | Yes | 1300 | Yes | 200 | Yes | 15 | No | 0.05 | No | 100 | NA | 2000 | Yes |
| Aquatic Life CALS | NA | | 0.27 | No | 9.3 | Yes | 5.2 | Yes | 3.2 | No | 0.91 | Yes | NA | | 120 | Yes |

HHS - Human Health Standards for Surface Water (DEQ, 2002)
MCL - Maximum Contaminant Level Drinking Water Regulations and Health Advisories, (EPA, 1993)
CALS - Freshwater Chronic Aquatic Life Standards (DEQ, 2002)
Water concentrations in ug/L.
CALS based on water hardness of 100 mg/L.

of Montana air quality regulations related to dust suppression and control during construction activities will be met using water sprays where applicable, i.e. excavation areas in the tailings and haul roads with heavy vehicular traffic.

Occupational Safety and Health Administration (OSHA) requirements would be met by requiring appropriate safety training for all on-site workers during the construction phase. Site activities would be conducted under the guidance of a Health and Safety Plan for the site as per OSHA 29 CFR 1910.120. Site personnel will have completed 40-hour hazardous waste operations and emergency response training and would be current on the 8-hour annual refresher training as required by OSHA.

### 8.2.3 Long-Term Effectiveness and Permanence

Establishing vegetation on the waste source would limit contaminant mobility. Vegetation stabilizes the surface against water and wind erosion and reduces the potential for contaminant migration into groundwater. Vegetation would also aid in reducing human and wildlife exposure to contaminants by direct contact and inhalation of dust. Under this alternative, the tailings cover and associated runon controls would have to be inspected and maintained to ensure that they continue to perform as designed. Maintenance requirements are expected to decrease after vegetation is well established.

### 8.2.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

Reduction of contaminant mobility by controlling exposure pathways is the primary objective of this alternative. The volume or toxicity of the contaminants in the consolidated tailings would not be physically nor chemically reduced. Stabilization and revegetation of the consolidated waste piles would reduce the contaminant mobility by the principal exposure pathways, surface water and wind erosion.

### 8.2.5 Short-Term Effectiveness

It is anticipated that construction activities related to the implementation of this alternative would be completed in a relatively short time frame, i.e., one or two single construction seasons. Therefore, impacts associated with construction activities would be considered short term and should not significantly impact human health nor the environment. On-site workers would be protected by following a site specific Health and Safety Plan, employing appropriate personal protective equipment and by following proper operating and safety procedures. However, short term air quality impacts to the immediate environment may occur due to the relatively large volumes of waste and cover soil requiring excavation, placement, and grading. Control of fugitive dusts may thus require the use of water sprays. Short-term impacts to the surrounding community are expected to be minimal due to the location of the project site. The only foreseen short-term impact to the surrounding community would involve increased vehicle traffic, with associated safety hazards and dust generation, on Marysville road.

### 8.2.6 Implementability

The alternative is both technically and administratively feasible. The excavation, consolidation, grading, capping, and revegetation steps associated with the tailings reclamation are considered conventional construction practices. Design methods and requirements are generally well documented. Materials and construction equipment should be readily available.

### 8.2.7 Costs

The total present worth cost for reclamation by consolidation/in-place containment is estimated at $1,388,221. Table 8-5 presents the cost details associated with implementing this alternative. The total cost includes the present-worth value of 30 years of annual maintenance and monitoring costs in addition to capital costs.

The general construction steps for implementing Alternative 3, are as follows:

- construction of a temporary surface water diversion to divert streamflow during construction activities at the Drumlummon tailings;
- removal and consolidation of the tailings from the northern portion of the drainage and consolidation;
- placement of riprap along the toe of the consolidated Drumlummon tailings;
- reconstruction of Silver Creek around the consolidated Drumlummon tailings area to pass the 100-year flood;
- consolidation and grading of the Goldsil tailings;
- placement of riprap along the toe of the consolidated Goldsil tailings;
- placement of cover soil on the Drumlummon millsite tailings, consolidated Drumlummon tailings, consolidated Goldsil tailings, and the Upper, Middle and Lower Pond tailings;
- constructing surface water diversion ditches strategically located to control water runon in the vicinity of the reclaimed waste piles during revegetation;
- establishing vegetation on the consolidated waste piles and excavated source areas by seeding and fertilizing;
- mulching of the seeded areas; and
- constructing a 4-strand, barbed-wire fence around the perimeter of the reclaimed waste piles.

**Table 8-5. Preliminary Cost Estimate for Alternative 3: Consolidation/In-Place Containment of Tailings**

| Task | Quantity | Units | Unit $ | Cost $ | Comment |
|---|---|---|---|---|---|
| Mobilization, Bonding & Insurance | 1 | L.S. | 79,741 | $79,741 | 8% |
| Logistics | | | | | |
| Site Clearing/Preparation | 38.99 | Ac | 2,000 | $77,975 | |
| Debris Removal and Onsite Disposal | 1 | LS | 30,000 | $30,000 | |
| In-Place Containment | | | | | |
| Grade Drumlummon Tailings | 23,610 | CY | 2.50 | $59,025 | |
| Consolidate Goldsil Tailings | 33,540 | CY | 2.50 | $83,850 | |
| Grade Main Goldsil Tailings | 137,840 | CY | 2.00 | $275,680 | |
| Goldsil Riprap Protection | 1,000 | CY | 25.00 | $25,000 | |
| Drumlummon Stream Channel | 1,030 | LF | 80.00 | $82,400 | Piegan-Gloster |
| Cover Soil (1 foot thick)* | | | | | |
| Drumlummon Millsite Tailings | 4,507 | CY | 8.10 | $36,507 | |
| Drumlummon Tailings | 5,582 | CY | 6.60 | $36,841 | |
| Goldsil Tailings | 29,009 | CY | 4.48 | $129,960 | |
| Upper Pond | 3,591 | CY | 2.50 | $8,978 | |
| Middle Pond | 3,161 | CY | 3.10 | $9,799 | |
| Lower Pond | 2,850 | CY | 2.50 | $7,125 | |
| Water Diversion/Runon Controls | | | | | |
| Run-on Control Ditch | 3,950 | LF | 2.00 | $7,900 | |
| Revegetation | | | | | |
| Seed/Fertilize | 38.99 | Ac | 1,000 | $38,987 | |
| Mulch | 38.99 | Ac | 1,000 | $38,987 | |
| Fencing | | | | | |
| Barbed-wire Fence | 19,100 | LF | 2.50 | $47,750 | |
| Subtotal | | | | $1,076,505 | |
| Construction Oversight | 15% | | | $161,476 | |
| Subtotal Capital Costs | | | | $1,237,981 | |
| Contingency | 10% | | | $123,798 | |
| TOTAL CAPITAL COSTS | | | | $1,361,779 | |
| POST CLOSURE MONITORING AND MAINTENANCE COSTS | | | | | |
| Inspections | 1 | /Year | 250 | $250 | |
| Sampling & Analysis | 4 | /Year | 200 | $800 | |
| Maintenance | 1 | L.S. | 1500 | $1,500 | |
| Subtotal | | | | $2,550 | |
| Contingency | 10% | | | $255 | |
| TOTAL ANNUAL O&M COST | | | | $2,805 | |
| TOTAL CAPITAL COSTS | | | | $1,361,779 | |
| PRESENT WORTH O&M COST | 30 | yrs @ | 10% | $26,442 | |
| **TOTAL PRESENT WORTH COST** | | | | $1,388,221 | |

*Note: Would need to identify addtional borrow soil (approximately 17000 CY)

## 8.3 ALTERNATIVE 4: IN-PLACE CONTAINMENT OF WASTE ROCK

In-place containment technologies may involve establishing vegetation directly on the waste source or applying a cover over the waste source upon which the vegetation is established. Covers may range from a simple, single-layered soil cover to a complex, multi-layered cover consisting of various materials.

The Drumlummon mine and millsite area contains four waste rock piles that are essentially steep, scree slopes with no vegetation, similar to natural talus slopes. Soil covers would be difficult to construct on the existing waste rock piles at the site because of the steep terrain. Soil covers are often subject to severe surface water erosion problems when placed on slopes steeper than 3H:1V. Therefore, soil amendments and/or covers are not considered to be feasible on the waste rock piles.

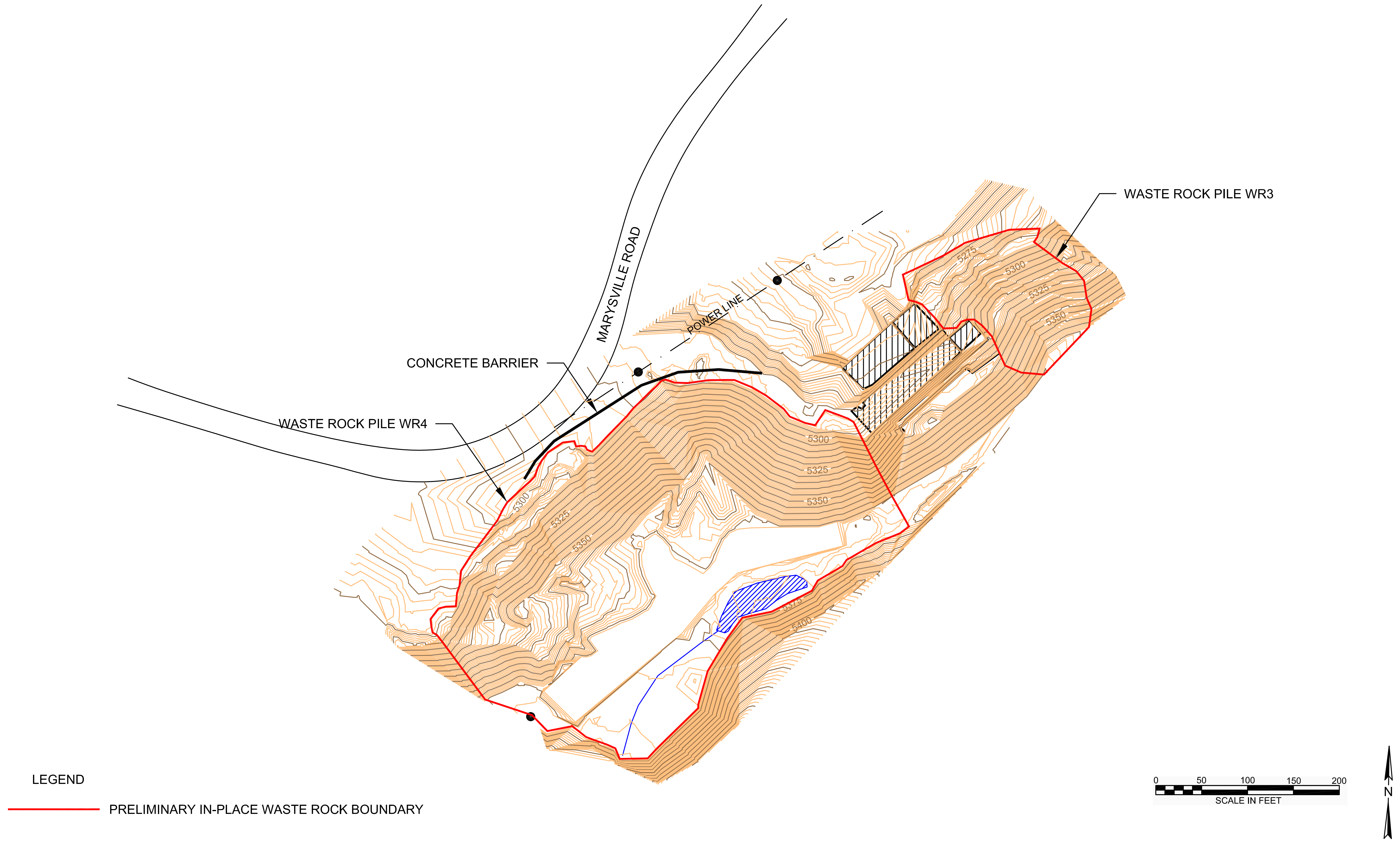
Under Alternative 4, the waste rock from piles WR-1, WR-2, WR-3 and WR-4 would be reclaimed by in-place containment. The conceptual design for Alternative 4 involves leaving piles WR-1, WR-2 and WR-3 in place in their current conditions, and grading WR-4 to fill in the over-steepened slope located on the north face. Figure 8-3 shows the preliminary design for the WR-4 grading and in-place containment. The fill would be obtained from the top of WR-4 and would be cast down the slope to reach an angle of repose slope, similar to the remainder of the north slope. Concrete median barriers would be placed around the northern perimeter of WR-4 adjacent to Marysville Road to block access.

### 8.3.1 Overall Protection of Human Health and the Environment

Protection of the environment would not generally be achieved under this alternative as a stand-alone reclamation alternative. This alternative does not address tailings in the Silver Creek Drainage Project area, which are the principal waste sources of concern, and it would not likely be implemented as a stand-alone alternative. However, Alternative 4 may be suitable if implemented in conjunction with a separate alternative that addresses the tailings. Prevention of direct human exposure via the pathway of concern would not be achieved as a stand-alone alternative. Ingestion of mercury via fish ingestion under a recreational exposure scenario would not be reduced. Protection of the environment would also not be achieved as a stand-alone alternative. Prevention of ecological exposures via exposure to sediment and soil sources would not be achieved as a stand-alone alternative: deer exposure to lead via ingestion of tailings salts would not be reduced; plant phytotoxicity to copper and zinc would not be reduced; acute aquatic life exposures to cadmium, copper and zinc in surface water would not be reduced, and aquatic life exposures to lead and mercury sediment would not be reduced. A risk reduction achievement matrix for the various pathways and contaminants, identified in the baseline human health risk assessment and the ecological risk assessment, is shown in Table 8-6.

### 8.3.2 Compliance with ARARs

Table 8-7 shows that drinking water MCLs and/or HHS are not met for cadmium, lead, and mercury and ambient water quality criteria are not met for cadmium, copper, cyanide, lead and zinc in Silver Creek as a stand-alone alternative. Background water quality exceeds MCLs




| NO. | REVISION DESCRIPTION | BY | DATE | DESIGN: | DRAWN: KSR | CHECKED: CRS |
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| | | | | APPROVED: | DATE: 4/2003 | JOB NO: A1348 |
| | | | | SCALE: AS SHOWN | FILENAME: A1348DMWR.dwg | |

MONTANA DEQ/MINE WASTE CLEANUP BUREAU
SILVER CREEK DRAINAGE PROJECT
LEWIS & CLARK COUNTY, MONTANA

**Olympus Technical Services, Inc.**

PRELIMINARY DESIGN OF
ALTERNATIVE 4 FOR
WASTE ROCK PILE WR-4

FIGURE
8-3

**Table 8-6. Risk Reduction Achievement Matrix for Alternative 4**

| Exposure Pathway | Risk Level | Antimony | | Cadmium | | Copper | | Cyanide | | Lead | | Mercury | | Silver | | Zinc | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal |
| Human Risk: | | | | | | | | | | | | | | | | | |
| Water Ingestion/Fish | HQ=1 | 36.7 | NA | 66.5 | Yes | 996 | Yes | 10200 | Yes | 165 | Yes | 0.294 | No | NA | | 34400 | Yes |
| Ingestion Pathway (ug/l) | Carc. 1E-06 | | | NA | | | | | | | | | | | | | |
| Soil Ingestion/Dust | HQ=1 | 586 | Yes | 1750 | Yes | 54200 | Yes | 11100 | Yes | 2200 | Yes | 440 | Yes | NA | | 440000 | Yes |
| Inhalation Pathway (mg/Kg) | Carc. 1E-06 | | | 38.9 | Yes | | | | | | | | | | | | |
| Ecological Risk Scenario: | EQ=1 | | | | | | | | | | | | | | | | |
| Deer - Tailings Salt Ingestion (mg/Kg) | LOAEL | NA | | 880 | Yes | NA | | NA | | 314 | No | NA | | NA | | NA | |
| Plant Phytotoxicity - Soil (mg/Kg) | Max Phytotox. | NA | | 8 | Yes | 125 | No | NA | | 400 | Yes | NA | | NA | | 400 | No |
| Aquatic Life - Water (ug/l) | AALS | NA | | 2.1 | No | 14 | No | 22 | Yes | 81.6 | Yes | 1.7 | Yes | 4.1 | NA | 120 | No |
| Aquatic Life - Sediment (ug/l) | PSQC | NA | | 9 | Yes | 390 | Yes | NA | | 110 | No | NA | | NA | | 270 | Yes |

Notes: NA - Not Applicable

LOAEL - Lower observed adverse effect level

AALS - Freshwater Acute Aquatic Life Standards (DEQ, 2002). Hardness = 100 mg/l $CaCO_3$ for hardness dependent elements.

PSQC - Proposed Sediment Quality Criteria

**Table 8-7. Water Quality ARARs Attainment for Alternative 4**

| | Antimony | | Cadmium | | Copper | | Cyanide | | Lead | | Mercury | | Silver | | Zinc | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal |
| Drinking Water MCL/HHS | 6 | NA | 5 | No | 1300 | Yes | 200 | Yes | 15 | No | 0.05 | No | 100 | NA | 2000 | Yes |
| Aquatic Life CALS | NA | | 0.27 | No | 9.3 | No | 5.2 | No | 3.2 | No | 0.91 | Yes | NA | | 120 | No |

HHS - Human Health Standards for Surface Water (DEQ, 2002)

MCL - Maximum Contaminant Level Drinking Water Regulations and Health Advisories, (EPA, 1993)

CALS - Freshwater Chronic Aquatic Life Standards (DEQ, 2002)

Water concentrations in ug/L.

CALS based on water hardness of 100 mg/L.

and/or HHS for lead and mercury and exceeds CALS for cadmium and lead. However, cleanup below background concentrations is not considered achievable. In addition, arsenic, iron and manganese also exceeded HHS in samples from the main Drumlummon adit discharge.

Implementation of this as a stand-alone alternative is also not expected to satisfy air quality regulations because tailings sources would be left exposed. The tailings have the highest potential for fugitive emissions based on grain size.

Location-specific ARARs are expected to be met in the implementation of this alternative. Contacts with the appropriate agencies and acquisition of required permits related to streambeds, floodplains, and archaeological/paleontological resources would be completed.

Action-specific ARARs are expected to be met including the hydrological regulations contained in the Strip and Underground Mine Reclamation Act. The waste rock materials of concern are derived from the beneficiation and extraction of ores and are therefore exempt from federal regulation under the Resource Conservation and Recovery Act (RCRA), 42 U.S.C. 6921 (b) (3) (A)(iii)(1994) as a hazardous waste. Mine and mill wastes are also excluded under the Montana Solid Waste Management Act (75-10-214 (1)(b) MCA. Any temporary stream diversions for construction activities will require coordination with the Montana Department of Fish, Wildlife, and Parks, The U.S. Army Corps of Engineers, the Montana Department of Natural Resources and Conservation, and the Lewis & Clark County Conservation District. Revegetation requirements contained in the Surface Mining and Control Reclamation Act would not be met because the waste rock piles would be left unvegetated. State of Montana air quality regulations related to dust suppression and control during construction activities will be met using water sprays where applicable.

Occupational Safety and Health Administration (OSHA) requirements would be met by requiring appropriate safety training for all on-site workers during the construction phase. Site activities would be conducted under the guidance of a Health and Safety Plan for the site as per OSHA 29 CFR 1910.120. Site personnel will have completed 40-hour hazardous waste operations and emergency response training and would be current on the 8-hour annual refresher training as required by OSHA.

### 8.3.3 Long-Term Effectiveness and Permanence

The waste rock piles have been in place for 50 to more than 100 years. The piles show no evidence of significant erosion or instability problems other than the man-made instability on the north face of WR-4 from unauthorized excavation. Since the piles are similar to natural talus slopes, they are armored from erosion and have remained stable since their original placement several decades ago.

### 8.3.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

Reduction of contaminant mobility by controlling exposure pathways is the primary objective of this alternative. The volume or toxicity of the contaminants in the waste rock would not be physically nor chemically reduced. Stabilization and barricading of waste rock pile WR-4 would reduce the contaminant mobility by unauthorized excavation.

### 8.3.5 Short-Term Effectiveness

It is anticipated that construction activities related to the implementation of this alternative would be completed in a relatively short time frame, i.e., one single construction season. Therefore, impacts associated with construction activities would be considered short term and should not significantly impact human health nor the environment. On-site workers would be protected by following a site specific Health and Safety Plan, employing appropriate personal protective equipment and by following proper operating and safety procedures. However, short term air quality impacts to the immediate environment may occur during the limited grading of waste rock pile WR-4. Control of fugitive dust may require the use of water sprays. Short-term impacts to the surrounding community are expected to be minimal due to the location of the project site. The only foreseen short-term impact to the surrounding community would involve increased vehicle traffic, with associated safety hazards and dust generation, on Marysville road.

### 8.3.6 Implementability

The alternative is both technically and administratively feasible. The grading and fencing associated with the reclamation are considered conventional construction practices. Design methods and requirements are generally well documented. Materials and construction equipment should be readily available, however, the construction is complicated by the steep terrain, which will require consideration in both the design and implementation of alternative.

### 8.3.7 Costs

The total present worth cost for reclamation by in-place containment is estimated at $177,343. Table 8-8 presents the cost details associated with implementing this alternative. The total cost includes the present-worth value of 30 years of annual maintenance and monitoring costs in addition to capital costs.

<u>Conceptual Design and Assumptions</u>

The conceptual design for Alternative 4 involves leaving piles WR-1, WR-2 and WR-3 in place in their current conditions, and grading WR-4 to fill in the over-steepened slope located on the north face. The fill would be obtained from the top of WR-4 and would be cast down the slope to reach an angle of repose slope, similar to the remainder of the north slope. Concrete median barriers would be placed around the northern perimeter of WR-4 adjacent to Marysville Road to block access.

As a supplemental item to the in-place containment of the waste rock, a chain-link fence would be installed around the perimeter of the open pits at the Drumlummon mine area (Figure 3-13) to restrict access and to mitigate the fall hazard risk associated with the steep highwalls.

The general construction steps for implementing Alternative 4 are as follows:

- site clearing, preparation and debris removal;
- grading the north face of waste rock pile WR-4 to fill in the over-steepened slope;

**Table 8-8. Preliminary Cost Estimate for Alternative 4: In-Place Containment of Waste Rock**

| Task | Quantity | Units | Unit $ | Cost $ | Comment |
|---|---|---|---|---|---|
| Mobilization, Bonding & Insurance | 1 | L.S. | 8,836 | $8,836 | 8% |
| Logistics | | | | | |
| Site Clearing/Preparation | 3.22 | Ac | 2,000 | $6,431 | |
| Debris Removal and Onsite Disposal | 1 | LS | 5,000 | $5,000 | |
| In-Place Containment | | | | | |
| WR4 Waste Rock Grading | 2,280 | CY | 3.00 | $6,840 | |
| Water Diversion/Runon Controls | | | | | |
| Run-on Control Ditch | 1,000 | LF | 2.00 | $2,000 | |
| Revegetation | | | | | |
| Seed/Fertilize | 3.22 | Ac | 1000 | $3,216 | |
| Mulch | 3.22 | Ac | 1000 | $3,216 | |
| Concrete Barriers | 300 | LF | 30 | $9,000 | |
| Fencing | | | | | |
| Barbed-wire Fence | 5,100 | LF | 2.50 | $12,750 | |
| Open Pit Chain-Link Fence | 3100 | LF | 20 | $62,000 | |
| Subtotal | | | | $119,289 | |
| Construction Oversight | 15% | | | $17,893 | |
| Subtotal Capital Costs | | | | $137,182 | |
| Contingency | 10% | | | $13,718 | |
| TOTAL CAPITAL COSTS | | | | $150,901 | |
| POST CLOSURE MONITORING AND MAINTENANCE COSTS | | | | | |
| Inspections | 1 | /Year | 250 | $250 | |
| Sampling & Analysis | 4 | /Year | 200 | $800 | |
| Maintenance | 1 | L.S. | 1500 | $1,500 | |
| Subtotal | | | | $2,550 | |
| Contingency | 10% | | | $255 | |
| TOTAL ANNUAL O&M COST | | | | $2,805 | |
| TOTAL CAPITAL COSTS | | | | $150,901 | |
| PRESENT WORTH O&M COST | 30 | yrs @ | 10% | $26,442 | |
| **TOTAL PRESENT WORTH COST** | | | | $177,343 | |

- constructing surface water diversion ditches strategically located to control water runon in the vicinity of WR-4;
- placing concrete barriers (i.e., highway median barriers) along the northern perimeter of WR-4 to prevent unauthorized excavation and removal of waste rock; and
- installing a chain-link fence around the perimeter of the four open pits in the Drumlummon mine area.

## 8.4 ALTERNATIVE 7B: ON-SITE DISPOSAL OF TAILINGS IN A CONSTRUCTED MODIFIED RCRA REPOSITORY IN THE GOLDSIL AREA

The reclamation strategy for Alternative 7b involves removing the tailings sources associated with Phases I and II of the Silver Creek Drainage Project, which are the principal sources of concern, and disposing these wastes in a constructed modified RCRA repository, which includes a single composite liner (without a leachate collection and removal system) and a multi-layered cap. The sources to be disposed in the repository include the Drumlummon millsite tailings piles, the Drumlummon tailings, the Goldsil tailings and the Upper, Middle and Lower Pond tailings areas. Implementing this alternative would provide an effective means of significantly reducing the risk of human exposure and environmental impacts from the contaminants of concern at the site. Figure 3-20 shows the preliminary repository design.

The HELP model was used to simulate the modified RCRA repository scenario. Based on representative soil properties for the 1.5-foot cover soil, geocomposite drainage layer, flexible membrane liner, geosynthetic clay liner, an average of 30 feet of tailings, a base flexible membrane liner, and a base geosynthetic clay liner, the predicted infiltration of water through the base geosynthetic liner is an average of 0.00000 inches per year over a 30-year period. An average of 14.497 inches of water per year is predicted to be lost through evapotranspiration, which is equivalent to 90.92 percent of the average annual precipitation. Surface water runoff accounts for a loss of 1.194 inches per year or 7.49 percent of precipitation. Lateral drainage from the geocomposite drainage layer accounts for a loss of 0.164 inches of water per year or 1.03 percent of precipitation. The remaining 0.56 percent of precipitation is accounted for by changes in water storage in the cover soil and tailings layers.

### 8.4.1 Overall Protection of Human Health and the Environment

This alternative provides control of direct exposure to the contaminated materials and reduction in risk to human health and the environment. It prevents further erosion and migration of contaminants from tailings source areas. Existing sediment in Silver Creek is not removed in this alternative, however, existing stream sediments should be diluted by mixing with natural sediment or through bedload dispersion downstream to achieve risk-based cleanup goals based on existing background levels.

Placing the wastes into a repository would prevent exposure by direct contact. Ingestion exposure to mercury via ingestion of contaminated fish is expected to be reduced to below risk-based cleanup goals since further erosion of contaminated sediments into Silver Creek would be prevented. Mercury exposure via the fish ingestion pathway would be reduced to levels consistent with background water quality. Cleanup below background concentrations is not considered achievable.

Protection of the environment would generally be achieved under this alternative. Prevention of ecological exposures via exposure to water, sediment, and soil sources would be achieved to the extent practicable: deer exposure to lead via ingestion of tailings salts; plant phytotoxicity to copper and zinc; acute exposure of aquatic life to copper and zinc; and aquatic life exposure to lead via sediment would be reduced to risk-based cleanup levels. Since the waste sources would be removed from Silver Creek, cadmium, copper and zinc concentrations in the surface water would be reduced to levels consistent with background, however, cadmium concentrations may not be reduced below acute aquatic life standards. Similarly, lead (and mercury, although no mercury standard exists) concentrations in sediments would be reduced as existing sediments are either diluted by mixing with natural sediment or through bedload dispersion downstream. A risk reduction achievement matrix for the various pathways and contaminants, identified in the baseline human health risk assessment and the ecological risk assessment, is shown in Table 8-9.

### 8.4.2 Compliance with ARARs

With the exception of cadmium, lead and mercury, contaminant-specific ARARs are expected to be met when implementing this alternative. Table 8-10 shows that drinking water MCLs and/or HHS for cadmium, copper, cyanide, and zinc and ambient water quality criteria for copper, cyanide, mercury, and zinc are achieved in Silver Creek under this alternative. This is based on the assumption that elevated levels of these contaminants in surface water are attributed to the presence of contaminated sediments in Silver Creek and that sediments will eventually be sufficiently diluted such that they do not cause significant metals loading to Silver Creek. Implementation of this alternative will prevent further erosion of contaminated sediments into Silver Creek. Drinking water MCLs and/or HHS for lead and mercury and ambient water quality criteria for cadmium and lead are not achieved under this alternative. Background water quality exceeds MCLs and/or HHS for lead and mercury and exceeds CALS for cadmium and lead. However, cleanup below background concentrations is not considered achievable.

Implementation of this alternative is also expected to satisfy air quality regulations because the repository cap and vegetation cover would stabilize the contaminant sources and inhibit fugitive emissions. The tailings have the highest potential for fugitive emissions based on grain size.

Location-specific ARARs are expected to be met in the implementation of this alternative. Contacts with the appropriate agencies and acquisition of required permits related to streambeds, floodplains, and archaeological/paleontological resources would be completed.

Action-specific ARARs are expected to be met including the hydrological regulations contained in the Strip and Underground Mine Reclamation Act. The tailings materials of concern are derived from the beneficiation and extraction of ores and are therefore exempt from federal regulation under the Resource Conservation and Recovery Act (RCRA), 42 U.S.C. 6921 (b) (3) (A)(iii)(1994) as a hazardous waste. Mine and mill wastes are also excluded under the Montana Solid Waste Management Act (75-10-214 (1)(b) MCA. Any temporary stream diversions for construction activities will require coordination with the Montana Department of Fish, Wildlife, and Parks, The U.S. Army Corps of Engineers, the Montana Department of Natural Resources and Conservation, and the Lewis & Clark County Conservation District. Revegetation requirements contained in the Surface Mining and Control Reclamation Act would be met. State of Montana air quality regulations related to dust suppression and control during construction activities will be met using water sprays where applicable, i.e. excavation areas in the tailings and haul roads with heavy vehicular traffic.

**Table 8-9. Risk Reduction Achievement Matrix for Alternative 7b**

| Exposure Pathway | Risk Level | Antimony | | Cadmium | | Copper | | Cyanide | | Lead | | Mercury | | Silver | | Zinc | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal |
| Human Risk: | | | | | | | | | | | | | | | | | |
| Water Ingestion/Fish | HQ=1 | 36.7 | NA | 66.5 | Yes | 996 | Yes | 10200 | Yes | 165 | Yes | 0.294 | Yes | NA | | 34400 | Yes |
| Ingestion Pathway (ug/l) | Carc. 1E-06 | | | NA | | | | | | | | | | | | | |
| Soil Ingestion/Dust | HQ=1 | 586 | Yes | 1750 | Yes | 54200 | Yes | 11100 | Yes | 2200 | Yes | 440 | Yes | NA | | 440000 | Yes |
| Inhalation Pathway (mg/Kg) | Carc. 1E-06 | | | 38.9 | Yes | | | | | | | | | | | | |
| Ecological Risk Scenario: | EQ=1 | | | | | | | | | | | | | | | | |
| Deer - Tailings Salt Ingestion (mg/Kg) | LOAEL | NA | | 880 | Yes | NA | | NA | | 314 | Yes | NA | | NA | | NA | |
| Plant Phytotoxicity - Soil (mg/Kg) | Max Phytotox. | NA | | 8 | Yes | 125 | Yes | NA | | 400 | Yes | NA | | NA | | 400 | Yes |
| Aquatic Life - Water (ug/l) | AALS | NA | | 2.1 | No | 14 | Yes | 22 | Yes | 81.6 | Yes | 1.7 | Yes | 4.1 | NA | 120 | Yes |
| Aquatic Life - Sediment (ug/l) | PSQC | NA | | 9 | Yes | 390 | Yes | NA | | 110 | Yes | NA | | NA | | 270 | Yes |

Notes: NA - Not Applicable
LOAEL - Lower observed adverse effect level
AALS - Freshwater Acute Aquatic Life Standards (DEQ, 2002). Hardness = 100 mg/l $CaCO_3$ for hardness dependent elements.
PSQC - Proposed Sediment Quality Criteria

**Table 8-10. Water Quality ARARs Attainment for Alternative 7b**

| | Antimony | | Cadmium | | Copper | | Cyanide | | Lead | | Mercury | | Silver | | Zinc | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal |
| Drinking Water MCL/HHS | 6 | NA | 5 | Yes | 1300 | Yes | 200 | Yes | 15 | No | 0.05 | No | 100 | NA | 2000 | Yes |
| Aquatic Life CALS | NA | | 0.27 | No | 9.3 | Yes | 5.2 | Yes | 3.2 | No | 0.91 | Yes | NA | | 120 | Yes |

HHS - Human Health Standards for Surface Water (DEQ, 2002)
MCL - Maximum Contaminant Level Drinking Water Regulations and Health Advisories, (EPA, 1993)
CALS - Freshwater Chronic Aquatic Life Standards (DEQ, 2002)
Water concentrations in ug/L.
CALS based on water hardness of 100 mg/L.

Occupational Safety and Health Administration (OSHA) requirements would be met by requiring appropriate safety training for all on-site workers during the construction phase. Site activities would be conducted under the guidance of a Health and Safety Plan for the site as per OSHA 29 CFR 1910.120. Site personnel will have completed 40-hour hazardous waste operations and emergency response training and would be current on the 8-hour annual refresher training as required by OSHA.

### 8.4.3 Long-Term Effectiveness and Permanence

This alternative would reduce contaminant mobility at the site by removing the highest risk, solid media contaminant sources and disposing of these wastes in an engineered repository. The tailings would be encapsulated in an engineered repository that would effectively isolate this waste and reduce contaminant mobility. Periodic inspections and maintenance would ensure the long-term stability of the repository.

### 8.4.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

Reduction of contaminant mobility is the primary objective of this alternative. The volume or toxicity of the contaminants in the tailings and waste rock would not be physically nor chemically reduced. The excavation of the tailings from the drainage area would reduce the contaminant mobility by moving the waste to a secure location. The primary waste sources of concern (tailings piles) would be encapsulated in an engineered structure and physical location which is protected from erosion and water infiltration problems.

### 8.4.5 Short-Term Effectiveness

It is anticipated that construction activities related to the implementation of this alternative would be completed in three to five construction seasons. Impacts associated with construction activities would be generally be less than 120 days per construction season and should not significantly impact human health nor the environment. Interim measures would be implemented to secure the project areas between construction seasons. The interim measures would include erosion control and seasonal stabilization of the repository to limit mobility and direct contact. On-site workers would be protected by following a site specific Health and Safety Plan, employing appropriate personal protective equipment and by following proper operating and safety procedures. However, short term air quality impacts to the immediate environment may occur due to the relatively large volume of waste excavation and hauling. Control of fugitive dust may require the use of water sprays. Short-term impacts to the surrounding community are expected to be minimal due to the location of the project site. The only foreseen short-term impact to the surrounding community would involve increased vehicle traffic, with associated safety hazards and dust generation, on Marysville Road.

### 8.4.6 Implementability

This alternative is both technically and administratively feasible. Waste removal, repository construction, and establishing vegetation are readily implementable using conventional construction techniques. Key project components, such as the availability of equipment, materials, and construction expertise, are present and would aid in the timely implementation and successful execution of the proposed project.

### 8.4.7 Costs

The total present-worth cost for this alternative has been estimated at $7,056,497 which represents the removal of the tailings to a constructed modified RCRA repository. Table 8-11 presents the cost details associated with implementing this alternative. The total cost includes the present-worth value of 30 years of annual maintenance and monitoring costs in addition to capital costs.

Conceptual Design and Assumptions

The repository would be constructed in an area that encompasses the existing lined tailings pond and adjacent areas to the south and west. This area comprises roughly 12.6 acres that appear to be appropriate for the construction of a repository. The proposed repository site is located on a relatively flat bench above Silver Creek, and would be constructed against the existing hillside on the south side of Silver Creek. Assuming that the tailings volume was deposited in an area of approximately 12.6 acres, the total height of the repository would be approximately 100 feet, with a maximum waste thickness of approximately 70 feet, in order to achieve a 4:1 side slope design in the final cap. Mill tailings from the Drumlummon millsite, Drumlummon tailings area, Goldsil tailings area and the Upper, Middle and Lower Pond areas will be excavated and placed in the repository. The anticipated schedule required to complete this alternative is three to five construction seasons, which would generally be less than 120 days per year. Interim measures would be implemented to secure the project areas between construction seasons. The interim measures would include erosion control and seasonal stabilization of the repository to limit mobility and direct contact.

Removal of the Drumlummon tailings would require the construction of a temporary diversion of Silver Creek while excavating the tailings. After the repository construction, waste excavation, and waste placement are complete, the excavated areas would be revegetated. Cover/fill soil may be required in the excavated areas to level and contour the areas to match the surrounding terrain. The seed beds would be prepared using conventional agricultural plowing. Seeding would likely take place during the fall of the year. The seed mixture and fertilizer would be applied simultaneously to the prepared seed beds via drill application. Mulch would be applied to promote temporary protection of exposed erodible surfaces. Wheat or barley straw mulch (certified weed-free) would be applied over the excavated areas and the repository cap with a tow spreader or pneumatic spreader utilizing tucking/crimping as the anchoring mechanism. A runon/runoff control ditch would be constructed in the area of the repository to divert runoff away from the repository cap. Barbed-wire fencing would be placed around the excavated waste source areas to allow the establishment of vegetation without interference from livestock. A woven-wire fence would be constructed around the repository to limit access.

The general construction steps for implementing Alternative 7b are as follows:

- completion of road improvements from the Drumlummon millsite tailings and the Upper, Middle and Lower Pond tailings to the repository area;
- site clearing, preparation and debris removal;

**Table 8-11. Preliminary Cost Estimate for Alternative 7b: On-Site Disposal of Tailings in a Constructed Modified RCRA Repository in the Goldsil Area**

| Task | Quantity | Units | Unit $ | Cost $ | Comment |
|---|---|---|---|---|---|
| Mobilization, Bonding & Insurance | 1 | L.S. | 411,656 | $411,656 | 8% |
| Logistics | | | | | |
| Access Road | 12,500 | LF | 2.00 | $25,000 | |
| Site Clearing/Preparation | 38.99 | Ac | 2,000 | $77,975 | |
| Debris Removal and Onsite Disposal | 1 | LS | 30,000 | $30,000 | |
| Repository Construction | | | | | |
| Repository Base Preparation | 6,630 | CY | 3.00 | $19,890 | |
| Repository Base Grading | 14.94 | Ac | 2,000 | $29,880 | |
| Install Geosynthetic Clay Liner | 72,321 | SY | 4.50 | $325,445 | |
| Install 30 mil Flexible Membrane Liner | 72,321 | SY | 6.00 | $433,926 | |
| Waste Load, Haul & Dump | | | | | |
| Drumlummon Millsite Tailings | 10,570 | CY | 6.90 | $72,933 | |
| Drumlummon Tailings | 59,780 | CY | 4.30 | $257,054 | |
| Goldsil Tailings | 491,970 | CY | 2.50 | $1,229,925 | |
| Upper Pond Tailings | 20,720 | CY | 4.20 | $87,024 | |
| Middle Pond Tailings | 11,110 | CY | 4.30 | $47,773 | |
| Lower Pond Tailings | 17,670 | CY | 4.40 | $77,748 | |
| Waste Grading and Compaction | 611,820 | CY | 2.00 | $1,223,640 | |
| Cap Construction | | | | | |
| Install Geosynthetic Clay Liner | 62,470 | SY | 4.50 | $281,115 | |
| Install Cap Liner (20 mil HDPE) | 62,470 | SY | 5.00 | $312,350 | |
| Install Geocomposite Drainage Layer | 62,470 | CY | 4.50 | $281,115 | |
| Cover Soil | | | | | |
| BS-1 | 7,800 | CY | 4.30 | $33,540 | |
| BS-2 | 11,100 | CY | 4.10 | $45,510 | |
| PT35 | 10,800 | CY | 5.80 | $62,640 | |
| Other (near BS-2) | 1,535 | CY | 4.10 | $6,294 | |
| Water Diversion/Runon Controls | | | | | |
| Run-on Control Ditch | 2,600 | LF | 2.00 | $5,200 | |
| Revegetation | | | | | |
| Seed/Fertilize | 59.07 | Ac | 1,000 | $59,074 | |
| Mulch | 59.07 | Ac | 1,000 | $59,074 | |
| Fencing | | | | | |
| Barbed-wire Fence | 17,550 | LF | 2.50 | $43,875 | |
| Repository Fence | 2,950 | LF | 6.00 | $17,700 | |
| Subtotal | | | | $5,557,355 | |
| Construction Oversight | 15% | | | $833,603 | |
| Subtotal Capital Costs | | | | $6,390,959 | |
| Contingency | 10% | | | $639,096 | |
| TOTAL CAPITAL COSTS | | | | $7,030,054 | |
| POST CLOSURE MONITORING AND MAINTENANCE COSTS | | | | | |
| Inspections | 1 | /Year | 250 | $250 | |
| Sampling & Analysis | 4 | /Year | 200 | $800 | |
| Maintenance | 1 | L.S. | 1500 | $1,500 | |
| Subtotal | | | | $2,550 | |
| Contingency | 10% | | | $255 | |
| TOTAL ANNUAL O&M COST | | | | $2,805 | |
| TOTAL CAPITAL COSTS | | | | $7,030,054 | |
| PRESENT WORTH O&M COST | 30 | yrs @ | 10% | $26,442 | |
| **TOTAL PRESENT WORTH COST** | | | | $7,056,497 | |

- repository base preparation and grading;
- installation of the base liners;
- excavation, loading, hauling, placement, grading and compaction of tailings from the identified source areas;
- installation of the cap liners and geocomposite drainage layer;
- excavation, loading, hauling, placement and grading of cover soil on the repository;
- constructing surface water diversion ditches strategically located to control water runon in the vicinity of the repository;
- establishing vegetation on the repository and excavated waste area by seeding and fertilizing;
- mulching of the seeded areas;
- constructing a 4-strand, barbed-wire fence around the perimeter of the excavated source areas; and
- constructing an 8-foot-high wire panel fence around the perimeter of the repository.

## 8.5 ALTERNATIVE 7C: ON-SITE DISPOSAL OF TAILINGS IN A CONSTRUCTED UNLINED REPOSITORY WITH A MULTI-LAYERED CAP IN THE GOLDSIL AREA

The reclamation strategy for Alternative 7c involves removing the tailings sources associated with Phases I and II of the Silver Creek Drainage Project, which are the principal sources of concern, and disposing these wastes in a constructed unlined repository with a multi-layered cap. The sources to be disposed in the repository include the Drumlummon millsite tailings piles, the Drumlummon tailings, the Goldsil tailings and the Upper, Middle and Lower Pond tailings areas. Implementing this alternative would provide an effective means of significantly reducing the risk of human exposure and environmental impacts from the contaminants of concern at the site. Figure 3-20 shows the preliminary repository design.

The HELP model was used to simulate the unlined repository with a multi-layered cap scenario. Based on representative soil properties for the 1.5-foot cover soil, geocomposite drainage layer, geosynthetic clay liner, and an average of 30 feet of tailings, the predicted infiltration of water through the tailings is an average of 0.00083 inches per year over a 30-year period. This is equivalent to 0.005 percent of the average annual precipitation of 15.94 inches. An average of 14.498 inches of water per year is predicted to be lost through evapotranspiration, which is equivalent to 90.93 percent of the average annual precipitation. Surface water runoff accounts for a loss of 1.194 inches per year or 7.49 percent of precipitation. Lateral drainage from the geocomposite drainage layer accounts for a loss of 0.162 inches of water per year or 1.02 percent of precipitation. The remaining 0.56 percent of precipitation is accounted for by changes in water storage in the cover soil and tailings layers. The 0.00083 inches per year over the 12.64 acre repository area that is predicted to percolate from the tailings is equal to a discharge rate of 0.8 gallons per day over a 30 year period.

### 8.5.1 Overall Protection of Human Health and the Environment

This alternative provides control of direct exposure to the contaminated materials and reduction in risk to human health and the environment. It prevents further erosion and migration of contaminants from tailings source areas. Existing sediment in Silver Creek is not removed in this alternative, however, existing stream sediments should be diluted by mixing with natural sediment or through bedload dispersion downstream to achieve risk-based cleanup goals based on existing background levels.

Placing the wastes into a repository would prevent exposure by direct contact. Ingestion exposure to mercury via ingestion of contaminated fish is expected to be reduced to below risk-based cleanup goals since further erosion of contaminated sediments into Silver Creek would be prevented. Mercury exposure via the fish ingestion pathway would be reduced to levels consistent with background water quality. Cleanup below background concentrations is not considered achievable.

Protection of the environment would generally be achieved under this alternative. Prevention of ecological exposures via exposure to water, sediment, and soil sources would be achieved to the extent practicable: deer exposure to lead via ingestion of tailings salts; plant phytotoxicity to copper and zinc; acute exposure of aquatic life to copper and zinc; and aquatic life exposure to lead via sediment would be reduced to risk-based cleanup levels. Since the waste sources would be removed from Silver Creek, cadmium, copper and zinc concentrations in the surface water would be reduced to levels consistent with background, however, cadmium concentrations may not be reduced below acute aquatic life standards. Similarly, lead (and mercury, although no mercury standard exists) concentrations in sediments would be reduced as existing sediments are either diluted by mixing with natural sediment or through bedload dispersion downstream. A risk reduction achievement matrix for the various pathways and contaminants, identified in the baseline human health risk assessment and the ecological risk assessment, is shown in Table 8-12.

### 8.5.2 Compliance with ARARs

With the exception of cadmium, lead and mercury, contaminant-specific ARARs are expected to be met when implementing this alternative. Table 8-13 shows that drinking water MCLs and/or HHS for cadmium, copper, cyanide, and zinc and ambient water quality criteria for copper, cyanide, mercury, and zinc are achieved in Silver Creek under this alternative. This is based on the assumption that elevated levels of these contaminants in surface water are attributed to the presence of contaminated sediments in Silver Creek and that sediments will eventually be sufficiently diluted such that they do not cause significant metals loading to Silver Creek. Implementation of this alternative will prevent further erosion of contaminated sediments into Silver Creek. Drinking water MCLs and/or HHS for lead and mercury and ambient water quality criteria for cadmium and lead are not achieved under this alternative. Background water quality exceeds MCLs and/or HHS for lead and mercury and exceeds CALS for cadmium and lead. However, cleanup below background concentrations is not considered achievable.

Implementation of this alternative is also expected to satisfy air quality regulations because the repository cap and vegetation cover would stabilize the contaminant sources and inhibit fugitive emissions. The tailings have the highest potential for fugitive emissions based on grain size.

**Table 8-12. Risk Reduction Achievement Matrix for Alternative 7c**

| Exposure Pathway | Risk Level | Antimony | | Cadmium | | Copper | | Cyanide | | Lead | | Mercury | | Silver | | Zinc | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal |
| Human Risk: | | | | | | | | | | | | | | | | | |
| Water Ingestion/Fish | HQ=1 | 36.7 | NA | 66.5 | Yes | 996 | Yes | 10200 | Yes | 165 | Yes | 0.294 | Yes | NA | | 34400 | Yes |
| Ingestion Pathway (ug/l) | Carc. 1E-06 | | | NA | | | | | | | | | | | | | |
| Soil Ingestion/Dust | HQ=1 | 586 | Yes | 1750 | Yes | 54200 | Yes | 11100 | Yes | 2200 | Yes | 440 | Yes | NA | | 440000 | Yes |
| Inhalation Pathway (mg/Kg) | Carc. 1E-06 | | | 38.9 | Yes | | | | | | | | | | | | |
| Ecological Risk Scenario: | EQ=1 | | | | | | | | | | | | | | | | |
| Deer - Tailings Salt Ingestion (mg/Kg) | LOAEL | NA | | 880 | Yes | NA | | NA | | 314 | Yes | NA | | NA | | NA | |
| Plant Phytotoxicity - Soil (mg/Kg) | Max Phytotox. | NA | | 8 | Yes | 125 | Yes | NA | | 400 | Yes | NA | | NA | | 400 | Yes |
| Aquatic Life - Water (ug/l) | AALS | NA | | 2.1 | No | 14 | Yes | 22 | Yes | 81.6 | Yes | 1.7 | Yes | 4.1 | NA | 120 | Yes |
| Aquatic Life - Sediment (ug/l) | PSQC | NA | | 9 | Yes | 390 | Yes | NA | | 110 | Yes | NA | | NA | | 270 | Yes |

Notes: NA - Not Applicable

LOAEL - Lower observed adverse effect level

AALS - Freshwater Acute Aquatic Life Standards (DEQ, 2002). Hardness = 100 mg/l CaCO3 for hardness dependent elements.

PSQC - Proposed Sediment Quality Criteria

**Table 8-13. Water Quality ARARs Attainment for Alternative 7c**

| | Antimony | | Cadmium | | Copper | | Cyanide | | Lead | | Mercury | | Silver | | Zinc | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal |
| Drinking Water MCL/HHS | 6 | NA | 5 | Yes | 1300 | Yes | 200 | Yes | 15 | No | 0.05 | No | 100 | NA | 2000 | Yes |
| Aquatic Life CALS | NA | | 0.27 | No | 9.3 | Yes | 5.2 | Yes | 3.2 | No | 0.91 | Yes | NA | | 120 | Yes |

HHS - Human Health Standards for Surface Water (DEQ, 2002)

MCL - Maximum Contaminant Level Drinking Water Regulations and Health Advisories, (EPA, 1993)

CALS - Freshwater Chronic Aquatic Life Standards (DEQ, 2002)

Water concentrations in ug/L.

CALS based on water hardness of 100 mg/L.

Location-specific ARARs are expected to be met in the implementation of this alternative. Contacts with the appropriate agencies and acquisition of required permits related to streambeds, floodplains, and archaeological/paleontological resources would be completed.

Action-specific ARARs are expected to be met including the hydrological regulations contained in the Strip and Underground Mine Reclamation Act. The tailings materials of concern are derived from the beneficiation and extraction of ores and are therefore exempt from federal regulation under the Resource Conservation and Recovery Act (RCRA), 42 U.S.C. 6921 (b) (3) (A)(iii)(1994) as a hazardous waste. Mine and mill wastes are also excluded under the Montana Solid Waste Management Act (75-10-214 (1)(b) MCA. Any temporary stream diversions for construction activities will require coordination with the Montana Department of Fish, Wildlife, and Parks, The U.S. Army Corps of Engineers, the Montana Department of Natural Resources and Conservation, and the Lewis & Clark County Conservation District. Revegetation requirements contained in the Surface Mining and Control Reclamation Act would be met. State of Montana air quality regulations related to dust suppression and control during construction activities will be met using water sprays where applicable, i.e. excavation areas in the tailings and haul roads with heavy vehicular traffic.

Occupational Safety and Health Administration (OSHA) requirements would be met by requiring appropriate safety training for all on-site workers during the construction phase. Site activities would be conducted under the guidance of a Health and Safety Plan for the site as per OSHA 29 CFR 1910.120. Site personnel will have completed 40-hour hazardous waste operations and emergency response training and would be current on the 8-hour annual refresher training as required by OSHA.

### 8.5.3 Long-Term Effectiveness and Permanence

This alternative would reduce contaminant mobility at the site by removing the highest risk, solid media contaminant sources and disposing of these wastes in an engineered repository. The tailings would be encapsulated in an engineered repository that would effectively isolate this waste and reduce contaminant mobility. Periodic inspections and maintenance would ensure the long-term stability of the repository.

### 8.5.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

Reduction of contaminant mobility is the primary objective of this alternative. The volume or toxicity of the contaminants in the tailings and waste rock would not be physically nor chemically reduced. The excavation of the tailings from the drainage area would reduce the contaminant mobility by moving the waste to a secure location. The primary waste sources of concern (tailings piles) would be encapsulated in an engineered structure and physical location which is protected from erosion and water infiltration problems.

### 8.5.5 Short-Term Effectiveness

It is anticipated that construction activities related to the implementation of this alternative would be completed in three to construction seasons. Impacts associated with construction activities would be generally be less than 120 days per construction season and should not significantly impact human health nor the environment. Interim measures would be implemented to secure the project areas between construction seasons. The interim measures would include erosion control and seasonal stabilization of the repository to limit mobility and direct contact. On-site workers would be protected by following a site specific Health and Safety Plan, employing appropriate personal protective equipment and by following proper operating and safety procedures. However, short term air quality impacts to the immediate environment may occur due to the relatively large volume of waste excavation and hauling. Control of fugitive dust may require the use of water sprays. Short-term impacts to the surrounding community are expected to be minimal due to the location of the project site. The only foreseen short-term impact to the surrounding community would involve increased vehicle traffic, with associated safety hazards and dust generation, on Marysville Road.

### 8.5.6 Implementability

This alternative is both technically and administratively feasible. Waste removal, repository construction, and establishing vegetation are readily implementable using conventional construction techniques. Key project components, such as the availability of equipment, materials, and construction expertise, are present and would aid in the timely implementation and successful execution of the proposed project.

### 8.5.7 Costs

The total present-worth cost for this alternative has been estimated at $5,848,352 which represents the removal of the tailings to a constructed unlined repository with a multi-layered cap. Table 8-14 presents the cost details associated with implementing this alternative. The total cost includes the present-worth value of 30 years of annual maintenance and monitoring costs in addition to capital costs.

<u>Conceptual Design and Assumptions</u>

The repository would be constructed in an area that encompasses the existing lined tailings pond and adjacent areas to the south and west. This area comprises roughly 12.6 acres that appear to be appropriate for the construction of a repository. The proposed repository site is located on a relatively flat bench above Silver Creek and would be constructed against the existing hillside on the south side of Silver Creek. Assuming that the tailings volume were deposited in an area of approximately 12.6 acres, the total height of the repository would be approximately 100 feet, with a maximum waste thickness of approximately 70 feet, in order to achieve a 4:1 side slope design in the final cap. Mill tailings from the Drumlummon millsite, Drumlummon tailings area, Goldsil tailings area and the Upper, Middle and Lower Pond tailings areas will be excavated and placed in the repository. The anticipated schedule required to complete this alternative is three to five construction seasons, which would generally be less than 120 days per year. Interim measures would be implemented to secure the project areas between construction seasons. The interim measures would include erosion control and seasonal stabilization of the repository to limit mobility and direct contact.

Removal of the Drumlummon tailings would require the construction of a temporary diversion of Silver Creek while excavating the tailings. After the repository construction, waste excavation, and waste placement are complete, the excavated areas would be revegetated. Cover/fill soil may be required in the excavated areas to level and contour the areas to match the surrounding

**Table 8-14. Preliminary Cost Estimate for Alternative 7c: On-Site Disposal of Tailings in a Constructed Unlined Repository with a Multi-Layered Cap in the Goldsil Area**

| Task | Quantity | Units | Unit $ | Cost $ | Comment |
|---|---|---|---|---|---|
| Mobilization, Bonding & Insurance | 1 | L.S. | 340,911 | $340,911 | 8% |
| Logistics | | | | | |
| Access Road | 12,500 | LF | 2.00 | $25,000 | |
| Site Clearing/Preparation | 38.99 | Ac | 2,000 | $77,975 | |
| Debris Removal and Onsite Disposal | 1 | LS | 30,000 | $30,000 | |
| Repository Construction | | | | | |
| Repository Base Preparation | 6,630 | CY | 3.00 | $19,890 | |
| Repository Base Grading | 14.94 | Ac | 2,000 | $29,880 | |
| Waste Load, Haul & Dump | | | | | |
| Drumlummon Millsite Tailings | 10,570 | CY | 6.90 | $72,933 | |
| Drumlummon Tailings | 59,780 | CY | 4.30 | $257,054 | |
| Goldsil Tailings | 491,970 | CY | 2.50 | $1,229,925 | |
| Upper Pond Tailings | 20,720 | CY | 4.20 | $87,024 | |
| Middle Pond Tailings | 11,110 | CY | 4.30 | $47,773 | |
| Lower Pond Tailings | 17,670 | CY | 4.40 | $77,748 | |
| Waste Grading and Compaction | 611,820 | CY | 2.00 | $1,223,640 | |
| Cap Construction | | | | | |
| Install Geotextile Cushion | 62,470 | SY | 3.00 | $187,410 | |
| Install Geosynthetic Clay Liner | 62,470 | SY | 4.50 | $281,115 | |
| Install Geocomposite Drainage Layer | 62,470 | CY | 4.50 | $281,115 | |
| Cover Soil | | | | | |
| BS-1 | 7,800 | CY | 4.30 | $33,540 | |
| BS-2 | 11,100 | CY | 4.10 | $45,510 | |
| PT35 | 10,800 | CY | 5.80 | $62,640 | |
| Other (near BS-2) | 1,535 | CY | 4.10 | $6,294 | |
| Water Diversion/Runon Controls | | | | | |
| Run-on Control Ditch | 2,600 | LF | 2.00 | $5,200 | |
| Revegetation | | | | | |
| Seed/Fertilize | 59.07 | Ac | 1,000 | $59,074 | |
| Mulch | 59.07 | Ac | 1,000 | $59,074 | |
| Fencing | | | | | |
| Barbed-wire Fence | 17,550 | LF | 2.50 | $43,875 | |
| Repository Fence | 2,950 | LF | 6.00 | $17,700 | |
| Subtotal | | | | $4,602,300 | |
| Construction Oversight | 15% | | | $690,345 | |
| Subtotal Capital Costs | | | | $5,292,645 | |
| Contingency | 10% | | | $529,264 | |
| TOTAL CAPITAL COSTS | | | | $5,821,909 | |
| POST CLOSURE MONITORING AND MAINTENANCE COSTS | | | | | |
| Inspections | 1 | /Year | 250 | $250 | |
| Sampling & Analysis | 4 | /Year | 200 | $800 | |
| Maintenance | 1 | L.S. | 1500 | $1,500 | |
| Subtotal | | | | $2,550 | |
| Contingency | 10% | | | $255 | |
| TOTAL ANNUAL O&M COST | | | | $2,805 | |
| TOTAL CAPITAL COSTS | | | | $5,821,909 | |
| PRESENT WORTH O&M COST | 30 | yrs @ | 10% | $26,442 | |
| **TOTAL PRESENT WORTH COST** | | | | $5,848,352 | |

terrain. The seed beds would be prepared using conventional agricultural plowing. Seeding would likely take place during the fall of the year. The seed mixture and fertilizer would be applied simultaneously to the prepared seed beds via drill application. Mulch would be applied to promote temporary protection of exposed erodible surfaces. Wheat or barley straw mulch (certified weed-free) would be applied over the excavated areas and the repository cap with a tow spreader or pneumatic spreader utilizing tucking/crimping as the anchoring mechanism. A runon/runoff control ditch would be constructed in the area of the repository to divert runoff away from the repository cap. Barbed-wire fencing would be placed around the excavated waste source areas to allow the establishment of vegetation without interference from livestock. A woven-wire fence would be constructed around the repository to limit access.

The general construction steps for implementing Alternative 7c are as follows:

- completion of road improvements from the Drumlummon millsite tailings and the Upper, Middle and Lower Pond tailings to the repository area;
- site clearing, preparation and debris removal;
- excavation, loading, hauling, placement, grading and compaction of tailings from the identified source areas;
- installation of the cap liners and geocomposite drainage layer;
- excavation, loading, hauling, placement and grading of cover soil on the repository;
- constructing surface water diversion ditches strategically located to control water runon in the vicinity of the repository;
- establishing vegetation on the repository and excavated waste area by seeding and fertilizing;
- mulching of the seeded areas;
- constructing a 4-strand, barbed-wire fence around the perimeter of the excavated source areas; and
- construction a woven-wire fence around the repository.

## 8.6 ALTERNATIVE 8. PARTIAL ON-SITE DISPOSAL OF WASTE ROCK IN THE DRUMLUMMON MINE OPEN PITS

The reclamation strategy for Alternative 8 involves removing waste rock from pile WR-4 and placing it in the open pits associated with the Drumlummon mine area. The primary purpose of this alternative is to mitigate the safety hazard associated with the steep highwalls in the open pits. There are a total of four open pit areas and the volumes and maximum highwall heights are summarized in Table 3-19. The maximum highwall height is approximately 100 feet in Pit #3. Figures 3-22 and 3-23 show the existing open pit topography and the preliminary waste rock repository design, respectively.

### 8.6.1 Overall Protection of Human Health and the Environment

Protection of the environment would not generally be achieved under this alternative as a stand-alone reclamation alternative. This alternative does not address tailings in the Silver Creek Drainage Project area, which are the principal waste sources of concern, and it would not likely be implemented as a stand-alone alternative. However, Alternative 8 may be suitable if implemented in conjunction with a separate alternative that addresses the tailings. Prevention of direct human exposure via the pathway of concern would not be achieved as a stand-alone alternative. Ingestion of mercury via fish ingestion under a recreational exposure scenario would not be reduced. Protection of the environment would also not be achieved as a stand-alone alternative. Prevention of ecological exposures via exposure to sediment and soil sources would not be achieved as a stand-alone alternative: deer exposure to lead via ingestion of tailings salts would not be reduced; plant phytotoxicity to copper and zinc would not be reduced; acute aquatic life exposures to cadmium, copper and zinc in surface water would not be reduced, and aquatic life exposures to lead and mercury sediment would not be reduced. A risk reduction achievement matrix for the various pathways and contaminants, identified in the baseline human health risk assessment and the ecological risk assessment, is shown in Table 8-15.

### 8.6.2 Compliance with ARARs

Table 8-16 shows that drinking water MCLs and/or HHS are not met for cadmium, lead, and mercury and ambient water quality criteria are not met for cadmium, copper, cyanide, lead and zinc in Silver Creek as a stand-alone alternative. Background water quality exceeds MCLs and/or HHS for lead and mercury and exceeds CALS for cadmium and lead. However, cleanup below background concentrations is not considered achievable.

Implementation of this as a stand-alone alternative is not also expected to satisfy air quality regulations because tailings sources would be left exposed. The tailings have the highest potential for fugitive emissions based on grain size.

Location-specific ARARs are expected to be met in the implementation of this alternative. Contacts with the appropriate agencies and acquisition of required permits related to streambeds, floodplains, and archaeological/paleontological resources would be completed.

Action-specific ARARs are expected to be met including the hydrological regulations contained in the Strip and Underground Mine Reclamation Act. The waste rock materials of concern are derived from the beneficiation and extraction of ores and are therefore exempt from federal regulation under the Resource Conservation and Recovery Act (RCRA), 42 U.S.C. 6921 (b) (3) (A)(iii)(1994) as a hazardous waste. Mine and mill wastes are also excluded under the Montana Solid Waste Management Act (75-10-214 (1)(b) MCA. Any temporary stream diversions for construction activities will require coordination with the Montana Department of Fish, Wildlife, and Parks, The U.S. Army Corps of Engineers, the Montana Department of Natural Resources and Conservation, and the Lewis & Clark County Conservation District. Revegetation requirements contained in the Surface Mining and Control Reclamation Act would be met in the backfilled open pit areas. The remaining waste rock piles would be left unvegetated. State of

**Table 8-15. Risk Reduction Achievement Matrix for Alternative 8**

| Exposure Pathway | Risk Level | Antimony | | Cadmium | | Copper | | Cyanide | | Lead | | Mercury | | Silver | | Zinc | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal |
| Human Risk: | | | | | | | | | | | | | | | | | |
| Water Ingestion/Fish | HQ=1 | 36.7 | NA | 66.5 | Yes | 996 | Yes | 10200 | Yes | 165 | Yes | 0.294 | No | NA | | 34400 | Yes |
| Ingestion Pathway (ug/l) | Carc. 1E-06 | | | NA | | | | | | | | | | | | | |
| Soil Ingestion/Dust | HQ=1 | 586 | Yes | 1750 | Yes | 54200 | Yes | 11100 | Yes | 2200 | Yes | 440 | Yes | NA | | 440000 | Yes |
| Inhalation Pathway (mg/Kg) | Carc. 1E-06 | | | 38.9 | Yes | | | | | | | | | | | | |
| Ecological Risk Scenario: | EQ=1 | | | | | | | | | | | | | | | | |
| Deer - Tailings Salt Ingestion (mg/Kg) | LOAEL | NA | | 880 | Yes | NA | | NA | | 314 | No | NA | | NA | | NA | |
| Plant Phytotoxicity - Soil (mg/Kg) | Max Phytotox. | NA | | 8 | Yes | 125 | No | NA | | 400 | Yes | NA | | NA | | 400 | No |
| Aquatic Life - Water (ug/l) | AALS | NA | | 2.1 | No | 14 | No | 22 | Yes | 81.6 | Yes | 1.7 | Yes | 4.1 | NA | 120 | No |
| Aquatic Life - Sediment (ug/l) | PSQC | NA | | 9 | Yes | 390 | Yes | NA | | 110 | No | NA | | NA | | 270 | Yes |

Notes: NA - Not Applicable
LOAEL - Lower observed adverse effect level
AALS - Freshwater Acute Aquatic Life Standards (DEQ, 2002). Hardness = 100 mg/l CaCO3 for hardness dependent elements.
PSQC - Proposed Sediment Quality Criteria

**Table 8-16. Water Quality ARARs Attainment for Alternative 8**

| | Antimony | | Cadmium | | Copper | | Cyanide | | Lead | | Mercury | | Silver | | Zinc | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal | Cleanup Goal | Achieve Goal |
| Drinking Water MCL/HHS | 6 | NA | 5 | No | 1300 | Yes | 200 | Yes | 15 | No | 0.05 | No | 100 | NA | 2000 | Yes |
| Aquatic Life CALS | NA | | 0.27 | No | 9.3 | No | 5.2 | No | 3.2 | No | 0.91 | Yes | NA | | 120 | No |

HHS - Human Health Standards for Surface Water (DEQ, 2002)
MCL - Maximum Contaminant Level Drinking Water Regulations and Health Advisories, (EPA, 1993)
CALS - Freshwater Chronic Aquatic Life Standards (DEQ, 2002)
Water concentrations in ug/L.
CALS based on water hardness of 100 mg/L.

Montana air quality regulations related to dust suppression and control during construction activities will be met using water sprays where applicable, i.e. excavation areas and haul roads with heavy vehicular traffic.

Occupational Safety and Health Administration (OSHA) requirements would be met by requiring appropriate safety training for all on-site workers during the construction phase. Site activities would be conducted under the guidance of a Health and Safety Plan for the site as per OSHA 29 CFR 1910.120. Site personnel will have completed 40-hour hazardous waste operations and emergency response training and would be current on the 8-hour annual refresher training as required by OSHA.

### 8.6.3 Long-Term Effectiveness and Permanence

Capping the backfilled open pits with cover soil and establishing vegetation would limit contaminant mobility. Vegetation stabilizes the surface against water and wind erosion and reduces the potential for contaminant migration into groundwater. Vegetation would also aid in reducing human and wildlife exposure to contaminants by direct contact and inhalation of dust. Under this alternative, the backfilled open pits and associated runon controls would have to be inspected and maintained to ensure that they continue to perform as designed. Maintenance requirements are expected to decrease after vegetation is well established.

### 8.6.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

Mitigation of the open pit highwalls associated with the Drumlummon Mine area is the primary objective of this alternative. Reduction of contaminant mobility will also be achieved, although the principal means of contaminant mobility is via the use of the waste rock as a borrow source. The volume or toxicity of the contaminants in the waste rock would not be physically nor chemically reduced. The excavation of the waste rock from the current, easily accessible area would reduce the contaminant mobility by the waste to a more secure location.

### 8.6.5 Short-Term Effectiveness

It is anticipated that construction activities related to the implementation of this alternative would be completed in a relatively short time frame, i.e., a single construction season. Therefore, impacts associated with construction activities would be considered short term and should not significantly impact human health nor the environment. On-site workers would be protected by following a site specific Health and Safety Plan, employing appropriate personal protective equipment and by following proper operating and safety procedures. However, short term air quality impacts to the immediate environment may occur due to the relatively large volume of waste excavation and hauling. Control of fugitive dust may require the use of water sprays. Short-term impacts to the surrounding community are expected to be minimal due to the location of the project site. The only foreseen short-term impact to the surrounding community would involve increased vehicle traffic, with associated safety hazards and dust generation, on Marysville Road in the vicinity of Marysville.

### 8.6.6 Implementability

The alternative is both technically and administratively feasible. The excavation, hauling, placement, grading, capping, and revegetation steps associated with the waste rock reclamation are considered conventional construction practices. Design methods and requirements are generally well documented. Materials and construction equipment should be readily available, however, the construction is complicated by the steep terrain, which will require consideration in both the design and implementation of alternative.

The two primary issues that would need to be addressed are the stability of the highwall and the stability of the pit floor. Spalling of the highwall during waste placement would constitute a serious safety hazard for workers. Similarly, the extent of mine workings below the pit floor are not known. Shallow workings below the pit floor could result in cave-ins, which would pose a serious safety hazard for workers. Geophysical investigations, such as ground penetrating radar, should be completed to evaluate the subsurface conditions prior to design and construction of the repository. Additionally, there are adit openings within the open pits. Bat habitat investigations would likely be required to determine if the open pit area repository would have significant adverse impacts on bat habitat. Another issue that must be addressed is the adit discharge above WR-4. The discharge from this adit currently ponds in a marshy area above WR-4 where it evaporates and/or infiltrates into the subsurface. If WR-4 is removed, the adit discharge would have to be accommodated in some manner.

### 8.6.7 Costs

The total present worth cost for reclamation of open pit highwalls by backfilling with waste rock from WR-4 has been estimated at $1,368,203. Table 8-17 presents the cost details associated with implementing this alternative. The total cost includes the present-worth value of 30 years of annual maintenance and monitoring costs in addition to capital costs.

<u>Conceptual Design and Assumptions</u>

This alternative would be designed to completely fill each pit area, thereby mitigating the exposed highwall. The combined volume of the four open pits is approximately 106,190 cubic yards. This volume would accommodate approximately 95 percent of waste rock pile WR-4. The remaining waste rock would be contained in place at its current location.

The discharge from the main Drumlummon adit currently ponds in a marshy area above WR-4 and evaporates and/or infiltrates. As part of this alternative, the adit water would be piped down the steep slope to near the mill foundation, where it would be routed to an infiltration gallery.

The general construction steps for implementing Alternative 8 are as follows:

- completion of road improvements from WR-4 to the open pit areas;
- site clearing and removal of debris from WR-4;
- excavation, hauling, and placement of waste rock pile WR-4 in the four open pits;
- grading and contouring of the waste rock in the open pits;

**Table 8-17. Preliminary Cost Estimate for Alternative 8: Partial On-Site Disposal of Waste Rock in the Drumlummon Mine Open Pits**

| Task | Quantity | Units | Unit $ | Cost $ | Comment |
|---|---|---|---|---|---|
| Mobilization, Bonding & Insurance | 1 | L.S. | 79,055 | $79,055 | 8% |
| Logistics | | | | | |
| Access Road | 11,000 | LF | 2.00 | $22,000 | |
| Site Clearing/Preparation | 3.56 | Ac | 2,000 | $7,118 | |
| Debris Removal and Onsite Disposal | 1 | LS | 5,000 | $5,000 | |
| Waste Load, Haul & Dump | | | | | |
| WR4 Excavation and Loading | 106,193 | CY | 2.00 | $212,386 | |
| Waste Hauling | 106,193 | CY | 3.90 | $414,153 | |
| Waste Rock Grading and Compaction | 106,193 | CY | 2.00 | $212,386 | |
| Cover Soil | | | | | |
| PT35 | 8,591 | CY | 9.10 | $78,174 | |
| Adit Water Diversion/Infiltration Gallery | 1 | LS | 10,000 | $10,000 | |
| Revegetation | | | | | |
| Seed/Fertilize | 7.11 | Ac | 1,000 | $7,109 | |
| Mulch | 7.11 | Ac | 1,000 | $7,109 | |
| Fencing | | | | | |
| Barbed-wire Fence | 5,100 | LF | 2.50 | $12,750 | |
| Subtotal | | | | $1,067,238 | |
| Construction Oversight | 15% | | | $160,086 | |
| Subtotal Capital Costs | | | | $1,227,324 | |
| Contingency | 10% | | | $122,732 | |
| TOTAL CAPITAL COSTS | | | | $1,350,056 | |
| POST CLOSURE MONITORING AND MAINTENANCE COSTS | | | | | |
| Inspections | 1 | /Year | 250 | $250 | |
| Maintenance | 1 | L.S. | 1500 | $1,500 | |
| Subtotal | | | | $1,750 | |
| Contingency | 10% | | | $175 | |
| TOTAL ANNUAL O&M COST | | | | $1,925 | |
| TOTAL CAPITAL COSTS | | | | $1,350,056 | |
| PRESENT WORTH O&M COST | 30 | yrs @ | 10% | $18,147 | |
| **TOTAL PRESENT WORTH COST** | | | | $1,368,203 | |

- placing cover soil on the graded waste rock;
- establishing vegetation on the backfilled open pit areas and excavated waste area by seeding and fertilizing;
- mulching of the seeded areas;
- constructing a 4-strand, barbed-wire fence around the perimeter of the reclaimed open pit and WR-4 areas; and
- piping of discharge water from the main Drumlummon adit to an infiltration gallery constructed near the existing mill foundation.

# 9.0 COMPARATIVE ANALYSIS OF RECLAMATION ALTERNATIVES

This section provides a comparison of the reclamation alternatives retained for the Phases I and II of the Silver Creek Drainage Project. The comparison focuses mainly on the following criteria: 1) the relative protectiveness of human health and the environment provided by the alternatives; 2) the long-term effectiveness provided by the alternatives; and 3) the estimated attainment of ARARs for each alternative. Qualitative comparisons are used to contrast the two threshold criteria of "overall protection of human health and the environment" and "compliance with ARARs" for each alternative. The primary balancing criteria are also compared, although, the evaluation of each of these criteria is very similar due to the technical similarities in the alternatives themselves, with the exception of costs. Table 9-1 presents a summary of the alternatives with respect to the first eight evaluation criteria.

Alternative 1 - No Action is not considered any further for this alternative would not address any of the environmental concerns raised for the site and would not meet contaminant-specific ARARs.

Alternatives 4 and 8, which address waste rock only, are not considered to be a stand-alone reclamation alternatives. These alternatives would provide stabilization and limited access to waste rock pile WR-4. However, in-place containment of waste rock could be an attractive alternative when used in conjunction with another alternative. Neither Alternative 4 or Alternative 8 provide any significant reduction in exposure risk for the contaminants identified at the site, however, the risk assessment (Section 5) shows that the waste rock piles do not pose a significant risk to human health or the environment. Alternative 8 provides for the mitigation of the open pit highwalls associated with the Drumlummon mine area.

Alternatives 3, 7b, and 7c are expected to achieve compliance with action-specific and location-specific ARARs, however, while these alternatives significantly reduce the risks associated with surface water, none of them are expected to satisfy all surface water quality ARARs. None of the alternatives are expected to meet surface water quality ARARs because chronic aquatic life standards for cadmium are exceeded in Silver Creek above the site. Additionally, drinking water ARARs are exceeded for lead and mercury in Silver Creek. When comparing the exposure pathways of direct contact, surface water and air, each of these alternatives provide similar short-term risk reduction for the contaminants at the site. Alternatives 7b and 7c would provide the greater long-term protection of human health and the environment because of the location away from the stream drainage and engineered repository caps.

None of the alternatives reduce the toxicity or volume of the contaminants of concern. The objective of the alternatives is to sever the exposure pathway and to limit the mobility of the contaminants. Limiting contaminant mobility will achieve protection of human health and the environment and will meet applicable ARARs identified for the site.

The short-term effectiveness is expected to be, for the most part, similar to each of the action alternatives. The alternatives are all technically similar and the construction steps required to implement them are expected to be accomplished in three to five field construction seasons of generally less than 120 days per year. Risk exposure to the community is expected to be minimal, with the exception of increased traffic on Marysville Road.

## TABLE 9-1. COMPARATIVE ANALYSIS OF ALTERNATIVES

| Assessment Criteria | Alternative 1: No Action | Alternative 3: Consolidation/In-Place Containment of Tailings | Alternative 4: In-Place Containment of Waste Rock | Alternative 7b: On-Site Disposal of Tailings in a Constructed Modified RCRA Repository in the Goldsil Area | Alternative 7c: On-Site Disposal of Tailings in a Constructed Unlined Repository with a Multi-Layered Cap in the Goldsil Area | Alternative 8: Partial On-Site Disposal of Waste Rock in the Drumlummon Mine Open Pits |
|---|---|---|---|---|---|---|
| **Overall Protection of Public Health, Safety and Welfare -** | No reduction in risk. | Containment and stabilization of tailings sources is expected to reduce human exposure risk. | Containment and stabilization of waste rock sources is not expected to reduce human exposure risk as a stand-alone alternative. | Consolidation, encapsulation and stabilization of tailings sources is expected to significantly to reduce human exposure. | Consolidation, encapsulation and stabilization of tailings sources is expected to significantly to reduce human exposure. | Containment and stabilization of waste rock sources is not expected to reduce human exposure risk as a stand-alone alternative. |
| Environmental Protectiveness | No protection offered. | Containment and stabilization of tailings sources is expected to reduce ecological exposure risk. | Containment and stabilization of waste rock sources is not expected to reduce human exposure risk as a stand-alone alternative. | Encapsulation and stabilization of tailings sources is expected significantly to reduce overall ecological exposure. | Encapsulation and stabilization of tailings sources is expected significantly to reduce overall ecological exposure. | Containment and stabilization of waste rock sources is not expected to reduce ecological exposure risk as a stand-alone alternative. |
| **Compliance with ARARs -**<br>Contaminant Specific | Would not be met. | Background for Pb and Hg in Silver Creek exceed drinking water MCLs/HHS. Background for Cd and Pb in Silver Creek exceeds CALs. | Background for Pb and Hg in Silver Creek exceed drinking water MCLs/HHS. Background for Cd and Pb in Silver Creek exceeds CALs. | Background for Pb and Hg in Silver Creek exceed drinking water MCLs/HHS. Background for Cd and Pb in Silver Creek exceeds CALs. | Background for Pb and Hg in Silver Creek exceed drinking water MCLs/HHS. Background for Cd and Pb in Silver Creek exceeds CALs. | Background for Pb and Hg in Silver Creek exceed drinking water MCLs/HHS. Background for Cd and Pb in Silver Creek exceeds CALs. |
| Location Specific | None apply. | Location-specific ARARs would be met. | Location-specific ARARs would be met. | Location-specific ARARs would be met. | Location-specific ARARs would be met. | Location-specific ARARs would be met. |
| Action Specific | None apply. | Action-specific ARARs would be met. | Action-specific ARARs would be met, except waste rock would be left unvegetated. | Action-specific ARARs would be met. | Action-specific ARARs would be met. | Action-specific ARARs would be met, except some waste rock would be left unvegetated. |
| **Long-Term Effectiveness and Performance -**<br>Magnitude of Risk Reduction | No reduction in CoCs in any environmental media, except by natural degradation/erosion. | Moderate overall risk reduction is expected with tailings removal from Silver Creek, consolidation, grading, capping and revegetation plan. | Minor reduction in CoCs as a stand-alone alternative except by natural degradation. | High overall risk reduction is expected with tailings removal from Silver Creek and placement in an engineered repository. | High overall risk reduction is expected with tailings removal from Silver Creek and placement in an engineered repository. | Minor reduction in CoCs as a stand-alone alternative except by natural degradation. |
| Adequacy and Reliability of Controls | No controls over any on-site contamination, no reliability. | Containment controls are adequate for intended purposes and long-term reliability is good with the removal of tailings from the vicinity of Silver Creek. | Minimal as a stand-alone alternative, some reduction via natural revegetation on waste rock piles. | Primary sources of concern will be adequately isolated from human and environmental receptors. | Primary sources of concern will be adequately isolated from human and environmental receptors. | Minimal as a stand-alone alternative. Some reduction from containment of most of waste rock pile WR-4 and via natural revegetation on remaining waste rock piles. |
| **Reduction of Toxicity, Mobility and Volume -**<br>Treatment Process Used and Materials Treated | None | No treatment, however, consolidation of wastes and in-place containment via cover and revegetation will reduce mobility of CoCs. Provides good protection of surface water and controls wind erosion. | None | No treatment, however, removal and encapsulation of primary sources of concern from near Silver Creek is expected to provide significant reduction in mobility of CoCs for all pathways. | No treatment, however, removal and encapsulation of primary sources of concern from near Silver Creek is expected to provide significant reduction in mobility of CoCs for all pathways. | No treatment, however, consolidation of waste rock pile WR-4 in the open pits and via cover and revegetation will provide minor reduction in mobility of CoCs. |
| Volume of Contaminated Materials Treated | No reduction in CoC toxicity, mobility or volume. | No volume actively treated, however, 311,820 cubic yards of tailings would be consolidated and capped. | No reduction in CoC toxicity, mobility or volume. | No volume actively treated, however, 611,820 cubic yards of tailings would be removed and isolated in the repository. | No volume actively treated, however, 611,820 cubic yards of tailings would be removed and isolated in the repository. | No reduction in CoC toxicity or volume. Minor reduction in mobility by containment and capping encapsulation of WR-4. |
| Expected Degree of Reduction | Minimal, via natural degradation only (potential for future increases in mobility of contaminants) | Volume or toxicity of wastes would not be reduced, however, mobility of CoCs would be moderately reduced. | Minimal, via natural degradation only | Volume or toxicity of wastes would not be reduced, however, mobility of CoCs would be significantly reduced. | Volume or toxicity of wastes would not be reduced, however, mobility of CoCs would be significantly reduced. | Minor risk reduction by containment and capping of WR-4 |
| **Short-Term Effectiveness -**<br>Protection of Community During Remedial Action | Not applicable. | Fugitive emissions control may be required during construction. Minimal impact on community with the exception of increased vehicle traffic on Marysville Road. | Fugitive emissions control may be required during construction. Minimal impact on community with the exception of increased vehicle traffic on Marysville Road. | Fugitive emissions control may be required during construction. Minimal impact on community with the exception of increased vehicle traffic on Marysville Road. | Fugitive emissions control may be required during construction. Minimal impact on community with the exception of increased vehicle traffic on Marysville Road. | Fugitive emissions control may be required during construction. Minimal impact on community with the exception of increased vehicle traffic on Marysville Road. |
| Protection of On-Site Workers During Removal Action | Not applicable. | Expected to be sufficient. Safety hazards more likely prevalent than hazards associated with wastes. | Expected to be sufficient. Safety hazards more likely prevalent than hazards associated with wastes. | Expected to be sufficient. Safety hazards more likely prevalent than hazards associated with wastes. | Expected to be sufficient. Safety hazards more likely prevalent than hazards associated with wastes. | Could be difficult because of safety hazards associated with the open pit highwalls and possible shallow underground workings |
| Environmental Impacts | Same as baseline conditions. | Environmental impacts possible due to tailings excavation activities near stream. | Environmental impacts possible due to waste rock grading activities near stream at WR-4. | Environmental impacts possible due to tailings excavation activities near stream. | Environmental impacts possible due to tailings excavation activities near stream. | Environmental impacts possible due to waste rock excavation activities near stream at WR-4. |
| Time Until Removal Action Objectives are Achieved | Not applicable. | One or two construction seasons. | One construction season. | Three to five construction seasons. | Three to five construction seasons. | One construction season. |
| **Implementability -**<br>Ability to Construct and Operate | No construction or operation involved. | Easily implementable. | Easily implementable. | Easily implementable. Liner installation will require intensive construction QA/QC. | Easily implementable. Liner installation will require intensive construction QA/QC. | Moderately difficult to implement because of safety hazards associated with the steep terrain, open pit highwalls and possible shallow workings beneath the pit floors. |
| Ease of Implementing More Action If Necessary | Not applicable. | Easily implementable (additional armoring or stabilization, etc.) if determined necessary. | Easily implementable if additional armoring or stabilization, etc. determined necessary. | Easily implementable if additional armoring or stabilization, etc. determined necessary. | Easily implementable if additional armoring or stabilization, etc. determined necessary. | Easily implementable if additional armoring or stabilization, etc. determined necessary. |
| Availability of Services and Capacities | Not applicable. | Available locally and within state. | Available locally and within state. | Available locally and within state. | Available locally and within state. | Available locally and within state. |
| Availability of Equipment and Materials | Not applicable. | Available locally and within state. | Available locally and within state. | Available locally and within state. | Available locally and within state. | Available locally and within state. |
| **Estimated Total Present Worth Cost** | **$0** | **$1,388,221** | **$177,343** | **$7,056,497** | **$5,848,352** | **$1,368,203** |

On-site workers will be required to have hazardous materials handling training and will be subject to a site specific Health and Safety Plan for their protection. Tailings and waste rock excavation activities in or near the Silver Creek stream channel and floodplain may have some short term impact to the environment, although efforts will be made to minimize the risk by temporary stream diversion. Because each of the alternatives will involve excavation and haulage of significant volumes of tailings or waste rock, localized air quality impacts may occur from fugitive dust emissions. Water sprays will be used to control dust emissions and to minimize dust exposure.

For ease of construction, Alternative 3 would probably be the easiest alternative to implement because the wastes of concern would be consolidated and contoured in place. Alternatives 7b and 7c would be more technically difficult to implement than Alternative 3 because of the significantly increased waste volume to move, the increased haul distance for the waste disposal, and the increased construction quality control for repository construction. Alternatives 7b and 7c would require more construction quality control for the liner installation. Although not considered a stand-alone alternative, Alternative 4 would be relatively easy to implement. Alternative 8 would be more technically difficult to implement than Alternative 4 because of safety concerns related to the highwall and the potential for cave-ins related to shallow underground workings.

Due to the large-scale nature of this reclamation project, in conjunction with the technical requirements applicable to installing surface water diversions, heavy equipment operation and grading requirements, only properly trained and experienced contractors/crews utilizing large-capacity equipment should perform the specified work. Small capacity equipment and/or inexperienced contractors and crews would likely prolong the construction phase and may result in increased costs and compromised performance.

Table 9-1 indicates the estimated total costs associated with each alternative. The no action and institutional controls alternatives are not considered feasible for they would not adequately address the identified risks to human health and the environment at the site. Of the various action alternatives considered for the site, Alternative 3 is the least costly, and Alternative 7b is the most costly. Estimated costs for Alternatives 3, 7b and 7c range from $1,388,221 to $7,056,497.

## 10.0 PREFERRED ALTERNATIVE

The principal waste sources associated with Phases I and II of the Silver Creek Drainage Project that are contributing to environmental impacts are the mill tailings and to a much lesser degree the waste rock. The mill tailings are elevated in metals/metalloids including: antimony, cadmium, copper, cyanide, lead, mercury, silver and zinc (concentrations greater than three times background). The Drumlummon millsite waste rock piles (WR-3 and WR-4) are elevated in lead and mercury.

The greatest risk to human health and the environment from waste sources associated with Phases I and II of the Silver Creek Drainage Project are the tailings piles via the direct contact, surface water and air exposure pathways. Based on the risk assessment, ingestion of mercury via contaminated fish is the principal contaminant of concern for human health, while copper, lead, and mercury are the principal contaminants of concern for ecological exposures.

None of the tailings or waste rock piles exceeded TCLP regulatory levels for metals. Acid base accounting results and field evidence indicate that the tailings and waste rock are probably not acid generating. The favorable acid base accounting and TCLP data support the use of an unlined repository with a multi-layered cap to control water infiltration.

The tailings piles are located in or near the Silver Creek stream drainage. The tailings piles are currently subject to erosion and infiltration of surface water, which contributes metals loading to surface water and stream sediment. Removal of the tailings from the drainage to an engineered repository would provide protection from the existing erosion and infiltration problems with a high degree of overall risk reduction.

Based on the conclusions of the detailed analysis and comparative analysis of alternatives, Alternative 7c - On-Site Disposal in a Constructed Unlined Repository with a Multi-Layered Cap is proposed as the preferred alternative for reclamation of the tailings associated with Phases I and II of the Silver Creek Drainage Project. This alternative is considered the most appropriate and cost-effective means to reduce risk to human health and the environment to an acceptable level. In summary, the reclamation strategy for Alternative 7c involves removing the tailings sources associated with Phases I and II of the Silver Creek Drainage Project and disposing these wastes in a constructed unlined repository with a multi-layered cap. The sources to be disposed in the repository include the Drumlummon millsite tailings piles, the Drumlummon tailings, the Goldsil tailings and the Upper, Middle and Lower Pond tailings areas. The repository would be constructed in an area that encompasses the existing lined tailings pond and adjacent areas to the south and west. The proposed repository site is located on a relatively flat bench above Silver Creek and would be constructed against the existing hillside on the south side of Silver Creek. Removal of the Drumlummon tailings would require the construction of a temporary diversion of Silver Creek while excavating the tailings. After the repository construction, waste excavation, and waste placement are complete, the excavated areas would be revegetated. A runon/runoff control ditch would be constructed in the area of the repository to divert runoff away from the repository cap. Barbed-wire fencing would be placed around the excavated waste source areas to allow the establishment of vegetation without interference from livestock. A woven-wire fence would be constructed around the repository to limit access.

At the present time, no decision has been made on the reclamation alternative for the waste rock piles. The disposition of the waste rock will be evaluated by the DEQ-MWCB in the future.

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# APPENDIX A

# DESCRIPTION OF FEDERAL AND STATE APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

## Table of Contents

## 1.0 INTRODUCTION

This description of the applicable or relevant and appropriate requirements (ARARs) was compiled from documents describing ARARs for abandoned mine sites that was produced by the Montana Department of Environmental Quality (DEQ) - Mine Waste Cleanup Bureau (MWCB) and other state agencies. These ARARs, along with those prepared by ARCO for the Streamside Tailings Operable Unit (ARCO, 1995) and the Montana DEQ Hazardous Waste Site Cleanup Bureau for mine sites were reviewed and updated by Olympus to develop a listing of potential Federal and State ARARs for the Silver Creek Drainage Project.

Section 121(d)(2) of the CERCLA, 42 United States Code (U.S.C.) § 9621(d)(2), requires that clean-up actions conducted under CERCLA achieve a level or standard of control which at least attains "any standard, requirement, criteria, or limitation under any Federal environmental law... or any [more stringent] promulgated standard, requirement, criteria or limitation under a State environmental or facility siting law... [which] is legally applicable to the hazardous substance concerned or is relevant and appropriate under the circumstances of the release of such hazardous substance or pollutant, or contaminant..." The standards, requirements, criteria, or limitations identified pursuant to this section are commonly referred to as "applicable or relevant and appropriate requirements (ARARs)."

Two general types of clean-up actions are recognized under CERCLA: removal actions and remedial actions. A removal action is an action to abate, prevent, minimize, stabilize, mitigate, or eliminate a release or threat of release. This action is often temporarily taken to alleviate the most acute threats or to prevent further spread of contamination until more comprehensive action can be taken. A remedial action is a thorough investigation, evaluation of alternatives, and determination and implementation of a comprehensive and fully protective remedy for the site.

ARARs may be either "applicable" or "relevant and appropriate" to remedial activities at a site but not both. Applicable requirements are those standards, requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site. A remedial action must satisfy all the jurisdictional prerequisites of a requirement for it to be applicable to the specific remedial action at a CERCLA site.

Relevant and appropriate requirements are those standards, requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that, while not "applicable" to hazardous substances, pollutants, contaminants, remedial actions, locations, or other circumstances at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site. Factors which may be considered in making this determination, when the factors are pertinent, are presented in 40 Code of Federal Regulations (CFR) § 300.400(g)(2). They include, among other considerations, examination of the purpose of the requirement and of the CERCLA action, the medium and substances regulated by the requirement and at the CERCLA site, the actions or activities regulated by the requirement and the remedial action contemplated at the site, and the potential use of resources affected by the requirement and the use or potential use of the affected resource at the CERCLA site.

ARARs are divided into contaminant-specific, location-specific, and action-specific requirements. Contaminant-specific requirements govern the release of materials possessing certain chemical or physical characteristics or containing specific chemical compounds into the environment. Contaminant-specific ARARs generally set human or environmental risk-based criteria and protocol which, when applied to site-specific conditions, result in the establishment of numerical action values. These values establish the acceptable amount or concentration of a chemical that may be found in, or discharged to, the ambient environment.

Location-specific ARARs relate to the geographic or physical position of the site, rather than to the nature of site contaminants. These ARARs place restrictions on the concentration of hazardous substances or the conduct of clean-up activities due to their location in the environment.

Action-specific ARARs are usually technology- or activity-based requirements or are limitations on actions taken with respect to hazardous substances. A particular remedial activity will trigger an action-specific ARAR. Unlike chemical- and location-specific ARARs, action-specific ARARs do not, in themselves, determine the remedial alternative. Rather, action-specific ARARs indicate how the selected remedy must be achieved.

Non-promulgated advisories or guidance documents issued by federal or state governments do not have the status of potential ARARs. However, these advisories and guidance documents are "To Be Considered (TBC)" when determining protective clean-up levels. The TBC category consists of advisories, criteria, or guidance that were developed by the U.S. Environmental Protection Agency (EPA), other federal agencies, or states that may be useful in developing CERCLA remedies. These categories may be considered as appropriate in selecting and developing clean-up actions.

As provided by Section 121 of CERCLA, 42 U.S.C. § 9621, only those state standards that are more stringent than any federal standard and that have been identified by the State in a timely manner are appropriately included as ARARs. Some state standards that are potentially duplicative of federal standards are identified here to ensure their timely identification and consideration in the event that they are not identified or retained in the federal ARARs. Duplicative or less stringent standards will be deleted as appropriate when the final determination of ARARs is presented.

CERCLA defines only federal environmental laws and state environmental or facility siting laws as ARARs. Remedial design, implementation, and operation and maintenance must, nevertheless, comply with all other applicable laws, both state and federal. Many such laws, while not strictly environmental or facility siting laws, have environmental impacts. Moreover, applicable laws that are not ARARs because they are not environmental or facility siting laws are not subject to the ARAR waiver provisions, and the administrative, as well as the substantive, provisions of such laws must be observed. A separate list attached to the state ARARs' list is a non-comprehensive identification of other state law requirements, which must be observed during remedial design, remedy implementation, operation, or maintenance.

The description of the federal (Section 2.0) and state (Section 3.0) ARARs that follows includes summaries of legal requirements that in many cases attempt to set out the requirement in a simple fashion useful in evaluating compliance with the requirement. In the event of any inconsistency between the law itself and the summaries in this section, the ARAR is ultimately the requirement as set out in the law, rather than any paraphrase provided here.

The potential Federal and State ARARs, advisories, and guidance that may be useful in reclaiming the Silver Creek Drainage Project are presented below in the following sections.

## 2.0 FEDERAL ARARS

Potential federal ARARs for the Silver Creek Drainage Project are presented below.

### 2.1 FEDERAL CONTAMINANT-SPECIFIC ARARS

#### 2.1.1 Clean Water Act (Applicable)

The Federal Clean Water Act (33 U.S.C. §§ 1251-1375) as amended by the Water Quality Act of 1987 (Public Law 100-4 § 103) provides the authority for each state to adopt water quality standards (40 CFR Part 131) designed to protect beneficial uses of each water body and requires each state to designate uses for each water body. EPA regulation requires states to establish antidegradation requirements. EPA has provided guidance to the states for this purpose ("Water Quality Criteria Summary"; Quality Criteria for Water 1986 - Update 2 EPA; May 1, 1987). Pursuant to this authority and the criteria established by Montana water quality regulations (ARM § 17.30.623), Montana established classification standards for discharge into the major river drainages. These classifications are presented in the state ARARs section.

At this time, EPA is relying on the State standards. EPA reserves the right to identify federal water quality criteria as ARARs for this action, if appropriate.

40 CFR Part 122 establishes the National Pollutant Discharge Elimination System (NPDES). The substantive requirements of general permits for storm water discharges from construction are relevant and appropriate. See 57 Fed. Reg. 41236, September 9, 1992. Montana has an EPA approved State program (MPDES) that is discussed in the state ARARs section.

#### 2.1.2 Safe Drinking Water Act (Relevant and Appropriate)

The Safe Drinking Water Act (SDWA) cited at 42 U.S.C. § 300f, et seq. has established the maximum contaminant levels (MCL) for chemicals in drinking water distributed in public water systems. The MCLs are contained in the national Primary and Secondary Drinking Water Regulations (40 CFR Parts 141 and 143). SDWA MCLs are not applicable to the reclamation activities at the site because the groundwater and surface water at each of the project subareas are not public water supplies. The SDWA MCLs are relevant and appropriate at each project subarea even though the groundwater and surface water are not currently part of a public water system because 54 wells have been identified within a 1-mile radius of the Drumlummon millsite, one well has been identified within a 1-mile radius of the Drumlummon tailings, 7 wells have been identified within a 1-mile radius of the Goldsil tailings and the Upper, Middle and Lower ponds and 55 wells have been identified within a 1-mile radius of the Silver Creek placer tailings. In addition, public water supplies are located at the Great Divide Ski Area and the Marysville House restaurant, which are within one mile upgradient of the Drumlummon millsite. The wells near the Drumlummon millsite are primarily upgradient and are located in the deeper bedrock aquifer. Wells near the Drumlummon and Goldsil tailings, and the Upper, Middle and Lower ponds are generally located on the hillsides above Silver Creek and are in the deeper bedrock aquifer. Wells near the Silver Creek placer tailings are primarily located downstream of the tailings. The Preamble to the National Oil and Hazardous Substance Contingency Plan (NCP) clearly states that the MCLs are relevant and appropriate for groundwater that is a current or potential source of drinking water (55 Fed. Reg. 8750 (March 8, 1990)) and is further supported by requirements of the NCP, 40 CFR, § 300.430(e)(2)(i)(B). MCLs developed under the SDWA generally are ARARs for current or potential drinking water sources.

Standards for potential contaminants of concern at the site are:

| Element | MCLs[a] (mg/L) | MT Human Health Standard[b] Surface Water (ug/L) | MT Human Health Standard[b] Groundwater (ug/L) |
|---|---|---|---|
| Antimony | 0.006 | 6 | 6 |
| Cadmium | 0.005 | 5 | 5 |
| Copper | 1.3 | 1,300 | 1,300 |
| Cyanide | 0.2 | 200 | 200 |
| Lead | 0.015 | 15 | 15 |
| Mercury | 0.002 | 0.05 | 2 |
| Silver | 0.1 | 100 | 100 |
| Zinc | 5 | 2,000 | 2,000 |

Note: [a] = Federal Primary and Secondary Maximum Contaminant Levels in Water
[b] = DEQ WQB Circular WQB-7 (January 2002)

The EPA has granted to the State of Montana primacy in the implementation and enforcement of the Safe Drinking Water Act (SDWA). Thus, the law commonly enforced in Montana is the state law. The state regulations substantially parallel the federal law.

### 2.1.3 Clean Air Act (Applicable)

Section 109 of the Clean Air Act (42 U.S.C. § 7409) and implementing regulations found at 40 CFR Part 50 set national primary and secondary ambient air quality standards. National primary ambient air quality standards define levels of air quality that are necessary, with an adequate margin of safety, to protect the public health. National secondary ambient air quality standard define levels of air quality that are necessary to protect public welfare from any known or anticipated adverse effects of a pollutant. The standards for particulate matter at 40 CFR § 50.6 are applicable for reclamation alternatives for the Silver Creek Drainage Project, particularly for the earth moving (load, haul, dump), grading, and capping activities. These standards must be met both during the design and implementation phases of the remedial action.

Particulate Matter

The ambient air quality standard for particulate matter of less than or equal to 10 micrometers in diameter (PM-10) is 150 micrograms per cubic meter, 24-hour average concentration; 50 micrograms per cubic meter, annual arithmetic mean for particulate matter of less than or equal to 10 micrometers in diameter.

In addition, state law provides an ambient air quality standard for settled particulate matter. Particulate matter concentrations in the ambient air shall not exceed the 30-day average of 10 grams per square meter. Administrative Rules of Montana (ARM) § 17.8.220 (applicable).

### 2.1.4 Resource Conservation and Recovery Act (Applicable)

Under 40 CFR Part 261, Subpart A defines the solid wastes (mining-related wastes) which are subject to regulations as hazardous wastes. This requirement is applicable to reclamation alternatives that involve treatment, storage, or disposal of hazardous wastes in a solid waste management unit (such as a surface impoundment, waste pile, land treatment unit, or landfill). The limits specified for ground water protection are the same as the maximum contaminant levels (MCL) for those substances as defined in Section 2.1.2.

## 2.2 FEDERAL LOCATION-SPECIFIC ARARS

### 2.2.1 National Historic Preservation Act (Applicable)

This statute, and implementing regulations (16 U.S.C. § 470, 40 CFR § 6.301(b), 36 CFR Part 800), requires federal agencies or federal projects to take into account the effect of any federally assisted undertaking or licensing on any district, site, building, structure, or object that is included in, or eligible for, the Register of Historic Places. Compliance with this ARAR requires consultation with the State Historic Preservation Officer (SHPO), who can identify historic properties and assess whether proposed clean-up actions will impact these resources.

### 2.2.2 Archeological and Historical Preservation Act (Applicable)

This statute and implementing regulations (16 U.S.C. § 469, 40 CFR § 6.301 (c)) establish requirements for the evaluation and preservation of historical and archaeological data, which may be destroyed through alteration of terrain as a result of a Federal construction project or a federally licensed activity or program. This requires a survey of the site for covered scientific, prehistorical or archaeological artifacts. Preservation of appropriate data concerning the artifacts is hereby identified as an ARAR requirement, to be completed during the implementation of the reclamation activities.

### 2.2.3 Historic Sites, Buildings and Antiquities Act (Applicable)

This Act (16 U.S.C. §§ 461 et seq.; 40 CFR § 6.301(a)) states that "in conducting an environmental review of a proposed EPA action, the responsible official shall consider the existence and location of natural landmarks using information provided by the National Park Service pursuant to 36 CFR § 62.6(d) to avoid undesirable impacts upon such landmarks." "National natural landmarks" are defined under 36 CFR § 62.2 as:

> National Natural Landmark is an area designated by the Secretary of the Interior as being of national significance to the United States because it is an outstanding example(s) of major biological and geological features found within the boundaries of the United States or its Territories or on the Outer Continental Shelf

Under the Historic Sites Act of 1935, the Secretary of the Interior is authorized to designate areas as National Natural Landmarks for listing on the National Registry of Natural Landmarks.

### 2.2.4 Protection of Wetlands Order (Applicable)

This requirement (40 CFR Part 6, Appendix A, Executive Order No. 11,990) mandates that Federal agencies and the Potentially Responsible Party (PRP) avoid, to the extent possible, the adverse impacts associated with the destruction or loss of wetlands and to avoid support of new construction in wetlands if a practicable alternative exists. Wetlands are defined as those areas that are inundated or saturated by groundwater or surface water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. For this project, jurisdictional wetland identification has not been performed; however, the preliminary assessment for the project area indicates wetlands exist because Silver Creek flows through the Drumlummon tailings and areas of ponds and associated wetlands vegetation along Silver Creek have tailings eroded into them. Compliance with this ARAR requires consultation with the U.S. Army Corps of Engineers and the U.S. Fish and Wildlife Service to determine the extent of wetlands and to ascertain the means and measures necessary to mitigate, prevent, and compensate for project related losses of wetlands.

### 2.2.5 Floodplain Management Order (Applicable)

This requirement (40 CFR Part 6, Appendix A, Executive Order No. 11,988) mandates that federally funded or authorized actions within the 100-year floodplain avoid, to the maximum extent possible, adverse impacts associated with development of a floodplain. Compliance with this requirement is detailed in "Policy on Floodplains and Wetland Assessments for CERCLA Actions," 1985. Specific measures to minimize adverse impacts will be identified following consultation with the appropriate agencies. The Silver Creek Drainage Project is not located within a designated 100-year floodplain.

### 2.2.6 Fish and Wildlife Coordination Act (Applicable)

This standard (16 U.S.C. §§ 661 et seq., 40 CFR § 6.302(g)) requires that Federal agencies or federally funded projects ensure that any modification of any stream or other water body affected by an action authorized or funded by the Federal agency provides for adequate protection of fish and wildlife resources. Compliance with this ARAR requires consultation with the U.S. Fish and Wildlife Service and the Wildlife Resources Agency of the affected state (State of Montana Department of Fish, Wildlife, and Parks) to ascertain the means and measures necessary to mitigate, prevent, and compensate for project-related losses of wildlife resources and to enhance the resources. Consultation will occur during the public comment period, and specific mitigative measures may be identified in consultation with the appropriate agencies, if alternatives, as developed, will affect a stream.

### 2.2.7 Endangered Species Act (Applicable)

This statute, and implementing regulations (16 U.S.C. §§ 1531 et seq., 50 CFR § 402 and 40 CFR § 6.302(h)), require that any federal activity or federally authorized activity may not jeopardize the continued existence of any threatened or endangered species or destroy or adversely modify critical habitat. Compliance with this requirement involves consultation with the U.S. Fish and Wildlife Service, resulting in a determination as to whether there are listed or proposed species or critical habitats present, and, if so, whether any proposed activities will impact such wildlife or habitat. At this time, no threatened or endangered species or critical habit has been identified in the project area.

### 2.2.8 Resource Conservation and Recovery Act (Relevant and Appropriate)

The requirements set forth at 40 CFR § 264.18(a) and (b) provide that: a) any hazardous waste facility must not be located within 61 meters (200 feet) of a fault; and b) any hazardous waste facility within the 100-year floodplain must be designed, constructed, operated and maintained to avoid washout. Any discrete disposal or storage facilities which remain on-site as part of remedial alternative must meet these standards.

## 2.3 FEDERAL ACTION-SPECIFIC ARARS

### 2.3.1 Surface Mining Control and Reclamation (Relevant and Appropriate)

This Act (30 U.S.C. §§ 1201-1328) and implementing regulations found at 30 CFR Parts 816 and 784 establish provisions designed to protect the environment from the effects of surface coal mining operations, and to a lesser extent, non-coal mining. The regulations require that revegetation be used to stabilize soil covers over reclaimed areas. These requirements are relevant and appropriate to the covering of discrete areas of contamination. They also require that revegetation be done according to a plan which specifies schedules, species which are diverse and effective, planting methods, mulching techniques, irrigation if appropriate, and appropriate soil testing. Reclamation performance standards are currently relevant and appropriate to mining waste sites.

### 2.3.2 Clean Water Act (Applicable)

40 CFR Part 122 establishes the National Pollutant Discharge Elimination System (NPDES). The substantive requirements of general permits for storm water discharges from construction are relevant and appropriate. See 57 Fed. Reg. 41,236, September 9, 1992. Montana has an EPA approved State program (MPDES) that is discussed in the State ARARs Section.

### 2.3.3 Resource Conservation and Recovery Act

Criteria for Classification of Solid Waste Disposal Facilities Practices (Applicable)

The criteria contained in 40 CFR Part 257 (Subtitle D) are used in accordance with RCRA guidance in determining which practices pose a reasonable probability of having an adverse effect on human health or the environment. RCRA Subtitle D establishes criteria which are, for the most part, environmental performance standards that are used by states to identify unacceptable solid waste disposal practices or facilities.

Regulation 40 CFR Part 257.3-1(a) states that facilities or practices in the floodplain shall not result in the washout of solid waste so as to pose a hazard to human life, wildlife, or land or water resources.

Regulation 40 CFR Part 257.3-2 provides for the protection of threatened or endangered species.

40 CFR Part 257.3-3 provides that a facility shall not cause the discharge of pollutants into waters of the United States; this includes dredged or fill materials.

40 CFR Part 257.3-4 states that a facility or practice shall not contaminate underground drinking water beyond the solid waste boundary.

Standards Applicable to Transporters of Hazardous Waste (Applicable)

The regulations at 40 CFR Part 263 establish standards that apply to persons that transport hazardous waste within the U.S. If hazardous waste is transported on a rail-line or public highway on-site, or if transportation occurs off-site, these regulations will be relevant and appropriate.

Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities (Relevant and Appropriate)

A. Releases from Solid Waste Management Units (Applicable)

The regulations at 40 CFR 264, Subpart F, establish requirements for groundwater protection for RCRA-regulated solid waste management units (i.e., waste piles, surface impoundments, land treatment units, and landfills). Subpart F provides for three general types of groundwater monitoring: detection monitoring, compliance monitoring and corrective action monitoring. Monitoring is required during the active life of a hazardous waste management unit. At closure, if all hazardous waste, waste residue, and contaminated subsoil is removed, no monitoring is required. If hazardous waste remains, the monitoring requirements continue during the 40 CFR § 264.117 closure period.

B. Closure and Post-Closure (Relevant and Appropriate)

40 CFR Part 264, Subpart G, establishes that hazardous waste management facilities must be closed in such a manner as to: a) minimize the need for further maintenance; and b) control, minimize or eliminate, to the extent necessary, to protect public health and the environment, post-closure escape of hazardous wastes, hazardous constituents, leachate, contaminated run-off or hazardous waste decomposition products to the ground or surface waters or to the atmosphere.

Facilities requiring post-closure care must undertake appropriate monitoring and maintenance actions, control public access, and control post-closure use of the property to ensure that the integrity of the final cover, liner, or containment system is not disturbed. 40 CFR § 264.117. In addition, all contaminated equipment, structures and soil must be properly disposed of or decontaminated unless exempt. 40 CFR § 264.114. A survey plat should be submitted to the local zoning authority and to the EPA Regional Administrator indicting the location and dimensions of landfill cells or other hazardous waste disposal units with respect to permanently surveyed benchmarks. 40 CFR § 264.116. 40 CFR § 264.228(a) requires that at closure, free liquids must be removed or solidified, the wastes stabilized, and the waste management unit covered.

C. Waste Piles (Applicable)

40 CFR Part 264, Subpart L, applies to owners and operators of facilities that store or treat hazardous waste in piles. The regulations require the use of run-on and run-off control systems and collection and hold systems to prevent the release of contaminants from waste piles.

D. Land Treatment (Applicable)

The requirements of 40 CFR Part 264, Subpart M, regulate the management of "land treatment units" that treat or dispose of hazardous waste; these requirements are applicable for any land treatment units established at the site. The owner or operator of a land treatment unit must design treatment so that hazardous constituents placed in the treatment zone are degraded, transformed, or immobilized within the treatment zone. "Hazardous constituents" are those identified in Appendix VIII of 40 CFR Part 261 that are reasonably expected to be in, or derived from, waste placed in or on the treatment zone. Design measures and operating practices must be set up to maximize the success of degradation, transformation, and immobilization processes. The treatment zone is the portion of the unsaturated zone below and including the land surface in which the owner or operator intends to maintain the conditions necessary for effect degradation, transformation, or immobilization of hazardous constituents. The maximum depth of the treatment zone must be no more than 1.5 meters (5 feet) from the initial soil surface and more than one meter (3 feet) above the seasonal high water table.

Subpart M also requires the construction and maintenance of control features that prevent the run-off of hazardous constituents and the run-on of water to the treatment unit. The unit must also be inspected weekly and after storms for deterioration, malfunctions, and improper functioning of wind dispersal control measures.

An unsaturated zone monitoring program must be established to monitor soil and soil-pore liquid to determine whether hazardous constituents migrate out of the treatment zone. Specifications related to the monitoring program are contained in section 264.278. There are no land treatment units proposed for the Silver Creek Drainage Project.

E. Landfills

Regulation 40 CFR Part 264, Subpart N, applies to entities that dispose of hazardous waste in landfills. The regulations specify appropriate liner systems and leachate collection systems for landfills, run-on and run-off management systems, and wind dispersal controls for landfills. These regulations set forth specific requirements for landfill monitoring and inspection, surveying and recordkeeping, and closure and post-closure care. There are no landfills proposed for the Silver Creek Drainage Project.

### 2.3.4 Hazardous Materials Transportation Act (Applicable)

The Hazardous Materials Transportation Act (49 U.S.C. §§ 5101-5105), as implemented by the Hazardous Materials Regulations (49 CFR Parts 10, 171-177), regulates the transportation of hazardous materials. The regulations apply to any alternatives involving the transport of hazardous waste off-site, on public highways on-site, or by rail.

### 2.4 OTHER FEDERAL LAWS

#### 2.4.1 Occupational Safety and Health Regulations (Applicable)

The federal Occupational Safety and Health Act (29 USC § 655) regulations found at 29 CFR § 1910 are applicable to worker protection during conduct of RI/FS or remedial activities at hazardous material sites.

## 3.0 STATE OF MONTANA ARARS

Potential state ARARs for the Silver Creek Drainage Project are presented below.

### 3.1 MONTANA CONTAMINANT-SPECIFIC ARARS

#### 3.1.1 Montana Water Quality Act (Applicable)

Under the state Water Quality Act, §§ 75-5-101 et seq., MCA, the state has promulgated regulations to preserve and protect the quality of surface waters in the state. These regulations classify state waters according to quality, place restrictions on the discharge of pollutants to state waters and prohibit the degradation of state waters. The requirements listed below are applicable water quality standards with which any remedial action must comply.

ARM 17.30.610(1) (Applicable) provides that specified waters in the Missouri River drainage basin which includes the Silver Creek drainage are classified B-1 for water use.

The standards for B-1 classification waters are contained in ARM 17.30.623 (Applicable) of the Montana Water Quality regulations. These standards place limits on fecal coliform content, dissolved oxygen concentration, pH balance, turbidity, water temperature, sediments, solids, oils, and color. Concentrations of toxic and deleterious substances which would remain in the water after conventional treatment cannot exceed MCLs, and concentrations of toxic and deleterious substances cannot exceed Gold Book levels. The B-1 classification standards also provide:

- During periods when the daily maximum water temperature is greater than 60°F, the geometric mean number of organisms in the fecal coliform group must not exceed 200 per 100 milliliters (ml), nor are 10 percent of the total samples during any 30-day period to exceed 400 fecal coliform per 100 ml.

- Dissolved oxygen concentration must not be reduced below the levels given in department Circular WQB-7.

- Induced variation of hydrogen ion concentration (pH) within the range of 6.5 to 8.5 must be less than 0.5 pH unit. Natural pH outside this range must be maintained without change. Natural pH above 7.0 must be maintained above 7.0.

- The maximum allowable increase above naturally occurring turbidity is 5 nephelometric turbidity units except as permitted in ARM 17.30.637.

- Temperature variations are specifically limited, depending upon the temperature range of the receiving water.

- No increases are allowed above naturally occurring concentrations of sediment, settable solids, oils, or floating solids, which will or are likely to create a nuisance or render the waters harmful, detrimental, or injurious to public health, recreation, safety, welfare, livestock, wild animals, birds, fish, or other wildlife.

- True color must not be increased more than five units above naturally occurring color.

- Concentrations of carcinogenic, bioconcentrating, toxic or harmful parameters which would remain in the water after conventional water treatment may not exceed the applicable standards set forth in department Circular WQB-7.

Additional restrictions on any discharge to surface waters are included in:

ARM 17.30.635 (Applicable) requires that industrial waste must receive, as a minimum, treatment equivalent to the best practicable control technology currently available (BPCTCA) as defined in 40 CFR Subchapter N and subsequent amendments. Industrial waste is defined as any waste substance from the process of business or industry or from the development of any natural resource, together with any sewage that may be present, Section 75-5-103, MCA. This section also requires that in designing a disposal system, stream flow dilution requirements must be based on the minimum consecutive 7-day average flow which may be expected to occur on the average of once in 10 years.

ARM 17.30.637 (Applicable), which prohibits discharges containing substances that will:

(a) settle to form objectionable sludge deposits or emulsions beneath the water's surface or upon adjoining shorelines;

(b) create floating debris, scum, a visible oil film (or be present in concentrations at or in excess of 10 milligrams per liter) or globules of grease or other floating materials;

(c) produce odors, colors or other conditions which create a nuisance or render undesirable tastes to fish flesh or make fish inedible;

(d) create concentrations or combinations of materials which are toxic or harmful to human, animal, plant or aquatic life; and

(e) create conditions which produce undesirable aquatic life.

ARM 17.30.637 also provides that leaching pads, tailing ponds, or water, waste, or product holding facilities must be located, constructed, operated, and maintained to prevent any discharge, seepage, drainage, infiltration, or flow which may result in pollution of state waters, and a monitoring system may be required to ensure such compliance. No pollutants may be discharged and no activities may be conducted which, either alone or in combination with other wastes or activities, result in the total dissolved gas pressure relative to the water surface exceeding 110 percent of saturation.

In determining ARARs, one should check the "prohibitions" set out in 17.30.637 for any site specific prohibitions.

ARM 17.30.501-518 provides that discharges to surface water or groundwater may be granted a mixing zone on a case by case basis by the DEQ in accordance with its written implementation policy and restrictions.

ARM 17.30.1345 (Applicable), adopts and incorporates the provisions of 40 CFR Part 125.3 for criteria and standards of the imposition of technology-based treatment requirements in MPDES permits. Although the permit requirement would not apply to on-site discharges, the substantive requirements of Part 125.3 are applicable (i.e., for toxic and non-conventional pollutants). Treatment must apply the best available technology (BAT) economically achievable and, for conventional pollutants, application of the best conventional pollutant control technology (BCT) is required. Where effluent limitations are not specified for the particular industry or industrial category at issue, BCT/BAT technology-based treatment requirements are determined on a case-by-case basis using best professional judgment (BPJ). See CERCLA Compliance with Other Laws Manual, Vol. I, August 1988, p.3-4 and 3-7.

The Water Quality Act and regulations also include non-degradation provisions which require that waters which are of higher quality than the applicable classification be maintained at that high quality, and discharges which would degrade that water are prohibited. Montana's standard for non-degradation of water quality is applicable for all constituents for which pertinent portions of the Silver Creek drainage are of higher quality than the B-1 classification. If any remedial action constitutes a new source of pollution or an increased source of pollution, the non-degradation standard requires the degree of waste treatment necessary to maintain the existing water quality of constituents that are of higher quality than the applicable classification.

ARM 17.30.702 and 705 (Applicable) defines "degradation" and applies non-degradation requirements to any activity of man which would cause a new or increased source of pollution to state waters.

ARM 17.30.706-708 (Applicable) establishes the informational requirements for nondegradation significance/authorization review and department procedures for nondegradation review and decisions.

ARM 17.30.715-717 (Applicable) establishes criteria for determining nonsignificant changes in water quality, categories of activities that cause nonsignificant changes in water quality, and the requirement for implementation of water quality protection practices.

The MPDES permit requirements are technically not applicable to remedial actions at CERCLA sites because ARM 17.30.1310(3) exempts "Any discharge in compliance with the instructions of an on-scene coordinator pursuant to 40 CFR Part 300 et seq. (the NCP)." This exemption is even broader than the 121(e) permit exemption, because it would apply even to an off-site discharge, if such discharge were "in compliance with the instructions of the OSC." The MPDES requirements could still be relevant and appropriate to discharges of pollutants as part of a remedial action. However, it would be probably be more appropriate to identify the federal requirements as the relevant and appropriate requirements because of the express state exemption, which arguably represents a determination that the state MPDES requirements are not relevant or appropriate. Note that this analysis does not apply to a site being addressed only under CECRA and not CERCLA, because the exemption applies only to the instructions of an OSC under the NCP.

The MPDES standards (the substantive requirements to be enforced through the permitting process) are set out in 17.30.1203-1209. These standards are all simply incorporations of the federal regulations.

### 3.1.2 Montana Water Use Act

Montana Groundwater Pollution Control System (Applicable)

ARM 17.30.1006 (Applicable) classifies groundwater into Classes I through IV based on the present and future most beneficial uses of the groundwater, and establishes groundwater quality standards applicable with respect to each groundwater classification. Groundwater classifications are based on natural specific conductance (ARM 17.30.1005). Class I is the highest quality class; class IV the lowest. ARM 17.30.1006 provides that Class I groundwaters have a specific conductance (SC) of less than or equal to 1,000 microSiemens/cm at 25° C. The SC of groundwater, including limited adit sampling, in the Silver Creek Drainage Project area ranges from 163 to 605 microSiemens/cm.

ARM 17.30.1005(2) and (3) (Applicable) provides that it is not necessary to treat discharges to a purer condition than the natural condition of the receiving water, within the meaning of 75-5-306, MCA. Further, groundwater standards may be exceeded within a mixing zone established pursuant to ARM 27.30.501 through 17.30.518.

ARM 17.30.1011 (Applicable) prohibits degradation and states any ground water whose existing quality is higher than the established groundwater quality standards for its classification must be maintained at that high quality in accordance with 75-5-303, MCA and ARM Title 17, chapter 30, subchapter 7.

### 3.1.3 Public Water Supplies Act

EPA has granted the State of Montana primacy in enforcement of the Safe Drinking Water Act. The state regulations under the state Public Water Supply Act, §§ 75-6-101 et seq., MCA, substantially parallel the federal law and are relevant and appropriate.

Public Water Supply Regulations (Relevant and Appropriate)

Note that ARM 17.38.203-207 specifies MCLs for inorganic, organic, turbidity, radiological, and microbiological parameters.

ARM 17.38.205 (Relevant and Appropriate) establishes the following maximum turbidity contaminant level for public water supply systems which use surface water in whole or in part:

1. One turbidity unit ("TU"), as determined by a monthly average, except that a level not exceeding 5 TU may be allowed if the supplier of water can demonstrate to the department that the higher turbidity does not:

    (a) interfere with disinfection;

    (b) prevent maintenance of an effective disinfectant agent throughout the distribution system; or

(c) interfere with microbiological determination.

2. 5 TU based on an average for two consecutive days.

Although no groundwater is being used at any of the project subareas for drinking water, two public water supplies, the Great Divide Ski Area and the Marysville House restaurant, are located within one mile of the Drumlummon Millsite and are upgradient from the waste sources. In addition, 54 wells have been identified within a 1-mile radius of the Drumlummon millsite, one well has been identified within a 1-mile radius of the Drumlummon tailings, 7 wells have been identified within a 1-mile radius of the Goldsil tailings and the Upper, Middle and Lower ponds, and 55 wells have been identified within a 1-mile radius of the Silver Creek placer tailings. Therefore, this ARAR is relevant and appropriate.

### 3.1.4 Clean Air Act

Air quality regulations pursuant to the Act, §§ 75-2-101 et seq., MCA, are discussed below.

ARM 17.8.222 (Applicable) specifies that no person shall cause or contribute to concentrations of lead in the ambient air which exceed the following: 90-day average -- 1.5 micrograms per cubic meter of air, 90-day average, not to be exceeded.

ARM 17.8.220 (Applicable) specifies that no person shall cause or contribute to concentrations of particulate matter in the ambient air such that the mass of settled particulate matter exceeds the following 30-day average: 10 grams per square meter, 30-day average, not to be exceeded.

ARM 17.8.223 (Applicable) specifies that no person may cause or contribute to concentrations of PM-10 in the ambient air which exceed the following standard:

1. 24-hour average: 150 micrograms per cubic meter of air, 24-hour average, with not more that one expected exceedance per calendar year.
2. Annual average: 50 micrograms per cubic meter of air, expected annual average, not to be exceeded.

ARM 17.8.304 (2) (Applicable) states that "no person may cause or authorize emissions to be discharged in the outdoor atmosphere from any source installed after November 23, 1968, that exhibit an opacity of 20% or greater averaged over six consecutive minutes."

ARM 17.8.308 (Applicable) states that no person shall cause or authorize the production, handling, transportation, or storage of any material unless reasonable precautions are taken to control emissions of airborne particulate matter.

ARM 17.8.341 (Applicable) adopts the standards of 40 CFR Part 61 setting forth emission standards for hazardous air pollutants.

ARM 17.24.761 (Applicable) requires a fugitive dust control program be implemented in reclamation operations and lists specific but non-exclusive measures as necessary components of such a program.

### 3.1.5 Occupational Health Act

Occupational health regulations pursuant to the Occupational Health Act (see § 50-70-113, MCA) are discussed below.

Occupational Health Regulations (Appropriate)

The occupational safety and health laws are applicable protections for employees working at CERCLA sites. See NCP, 40 CFR § 300.150. The occupational health laws identified below prescribe certain limits of exposure considered necessary to protect the health of those with sustained exposure to specified substances. The nature of this removal action may subject persons other than employees to exposures sustained throughout the work period. These limits must be considered relevant and appropriate for those living or present in the areas affected by the removal action.

ARM 17.74.102 (Applicable) establishes maximum threshold limit values for air contaminants under which it is believed that nearly all workers may be repeatedly exposed day after day without adverse health effects. In accordance with this rule, no worker (or other person in or near the work site) shall be exposed to air contaminant levels in excess of the threshold limit values listed in each of the tables below. Compliance with the rule is determined by calculating the person's exposure to air contaminants as individual substances or as the exposure to a mixture of substances in accordance with formulas established by this rule. A person's exposure to any contaminant in the following table shall at no time exceed the threshold limit value listed:

| Air Contaminant | Concentration ($mg/m^3$) |
|---|---|
| Arsenic and compounds (as As) | 0.01 |
| Cadmium | 0.005 |
| Chromium | 0.5 |
| Cobalt | 0.1 |
| Copper dust and mist | 1.0 |
| Cyanide | 5.0 |
| Lead | 0.05 |
| Manganese | 5.0 |
| Mercury | 0.1 |
| Molybdenum | |
| Soluble compounds | 5.0 |
| Insoluble compounds | 15.0 |
| Silver, Metal and soluble compounds | 0.01 |
| Zinc | 5.0 |

ARM 17.74.101 (Applicable) establishes occupational noise levels and provides that no worker shall be exposed to noise levels in excess of specified levels.

## 3.2 MONTANA LOCATION-SPECIFIC ARARS

### 3.2.1 Floodplain and Floodway Management Act

Section 76-5-401, MCA, (Applicable) specifies the types of uses permissible in a designated 100-year floodway or floodplain and generally prohibits permanent structures, fill or permanent storage of materials or equipment.

Section 76-5-402, MCA, (Applicable) specifies uses allowed in the floodplain, excluding the floodway, and allows structures meeting certain minimum standards.

Section 76-5-403, MCA, (Applicable) lists certain uses which are prohibited in a designated floodway, including:

- any building for living purposes or place of assembly or permanent use by human beings;
- any structure or excavation that will cause water to be diverted from the established floodway, cause erosion, obstruct the natural flow of water, or reduce the carrying capacity of the floodway; or
- the construction or permanent storage of an object subject to flotation or movement during flood level periods.

<u>Floodplain Management Regulations</u>

ARM 36.15.216 (Applicable - substantive provisions only) specifies factors to consider in determining whether a permit should be issued to establish or alter an artificial obstruction or nonconforming use in the floodplain or floodway. While permit requirements are not directly applicable to activities conducted entirely on site, the criteria used to determine whether to approve establishment or alteration of an artificial obstruction or nonconforming use should be applied by the decision-makers in evaluating proposed remedial alternatives which involve artificial obstructions or nonconforming uses in the floodway or floodplain. Thus the following criteria are relevant and appropriate considerations in evaluating any such obstructions or uses:

- the danger to life and property from backwater or diverted flow caused by the obstruction;
- the danger that the obstruction will be swept downstream to the injury of others;
- the availability of alternative locations;
- the construction or alteration of the obstruction in such a manner as to lessen the danger;
- the permanence of the obstruction; and
- the anticipated development in the foreseeable future of the area which may be affected by the obstruction.

ARM 36.15.601 (Applicable - substantive provisions only) specifies open space uses which shall be allowed without a permit anywhere in the designated floodway provided that they are not prohibited by any other ordinance or statute and provided that they do not require structures other than portable structures, fill or permanent storage of materials or equipment.

ARM 36.15.602 (Applicable - substantive provisions only) specifies conditions for allowing certain artificial obstructions in a designated floodway, including conditions for excavation of material from pits or pools within the floodway.

ARM 36.15.603 (Applicable - substantive provisions only) provides that proposed diversions or changes in place of diversion must be evaluated by the Montana Department of Natural Resources and Conservation (MDNRC) to determine whether they may significantly affect flood flows and, therefore, require a permit. While permit requirements are not applicable for remedial actions conducted entirely on site, the following criteria used to determine when a permit shall not be granted are relevant and appropriate:

- The proposed diversion will increase the upstream elevation of the 100-year flood a significant amount (one-half foot or as otherwise determined by the permit issuing authority).

- The proposed diversion is not designed and constructed to minimize potential erosion from a flood of 100-year frequency.

- Any permanent diversion structure crossing the full width of the stream channel is not designed and constructed to safely withstand up to a flood of 100-year frequency.

ARM 36.15.604 (Applicable - substantive provisions only) precludes new construction or alteration of an artificial obstruction that will significantly increase the upstream elevation of the flood of 100-year frequency (0.5 feet or as otherwise determined by the permit issuing authority) or significantly increase flood velocities.

ARM 36.16.605(1) and (2) (Applicable - substantive provisions only) enumerate artificial obstructions and non-conforming uses that are prohibited within the designated floodway except as allowed by permit and includes "a structure or excavation that will cause water to be diverted from the established floodway, cause erosion, obstruct the natural flow of water, or reduce the carrying capacity of the floodway...". Solid and hazardous waste disposal and storage of toxic, flammable, hazardous, or explosive materials are also prohibited.

ARM 36.15.606 (Applicable - substantive provisions only) enumerates flood control works that are allowed within designated floodways pursuant to permit. Although the permit requirements are not applicable for activities conducted entirely on site, the following conditions are relevant and appropriate:

- Flood control levies and flood walls are allowed if they are designed and constructed to safely convey a flood of 100-year frequency, and their cumulative effect combined with allowable flood fringe encroachments does not increase the unobstructed elevation of a flood of 100-year frequency more than one-half foot at any point.

- Riprap, if not hand placed, is allowed if it is designed to withstand a flood of 100-year frequency; does not increase the elevation of the 100-year frequency flood; and will not increase erosion upstream, downstream, or across stream from the riprap site.

- Channelization projects are allowed if they do not significantly increase the magnitude, velocity, or elevation of the flood of 100-year frequency downstream from such projects.

- Dams are allowed if they are designed and constructed in accordance with approved safety standards and they will not increase flood hazards downstream either through operational procedures or improper hydrologic design.

ARM 36.15.701 (Applicable) requires that, within the flood fringe area, public or private structures and facilities for liquid or solid waste treatment and disposal must be flood-proofed to ensure that no pollutants enter flood waters.

ARM 36.15.703 (Applicable) is applicable in flood fringe areas (i.e., areas in the floodplain but outside of the designated floodway) of the site and prohibits, with limited exceptions, solid and hazardous waste disposal and storage of toxic, flammable, hazardous, or explosive materials.

ARM 36.15.801 (Applicable) states that wildlife management and natural areas are permitted and encouraged uses within a floodplain.

The Silver Creek Drainage Project is not located in a designated 100-year floodplain.

### 3.2.2 Natural Streambed and Land Preservation Act

Natural Streambed and Land Preservation Standards

Reclamation activities proposed for the Silver Creek Drainage Project will alter or affect a perennial stream. Silver Creek is assigned a Fisheries Resource Values of 4 for both habitat class and sport class, with a final value of moderate in the Montana Rivers Information System (MRIS) database. Trout were observed by Olympus in a pond below the Goldsil millsite during the site characterization. Section 87-5-501, MCA, (Applicable) declares that the fish and wildlife resources of the State of Montana, particularly the fishing waters, are to be protected and preserved to the end that they be available for all time, without change, in their natural existing state except as may be necessary and appropriate after due consideration of all factors involved.

Sections 87-5-502 and 504, MCA, (Applicable - substantive provisions only) provide that a state agency or subdivision shall not construct, modify, operate, maintain or fail to maintain any construction project or hydraulic project which may or will obstruct, damage, diminish, destroy, change, modify, or vary the natural existing shape and form of any stream or its banks or tributaries in a manner that will adversely affect any fish or game habitat. This requirement is relevant and appropriate for entities carrying out remedial actions approved by the state.

ARM 36.2.410 (Applicable) defines project information which applicant must provide to the conservation district and provides that a stream must be designed and constructed to minimize adverse impacts to stream, future disturbances to the stream and erosion; temporary structures used during construction must handle reasonably anticipated high flows; channel alteration must be designed to retain original stream length or otherwise provide for hydrologic stability; streambank vegetation must be protected except where removal is necessary and riprap, rock, or other material must be sized adequately to protect streambank erosion.

### 3.2.3 Antiquities Act

Section 22-3-424, MCA, (Relevant and Appropriate) requires that the identification and protection of heritage properties and paleontological remains on lands owned by the state are given appropriate consideration in state agency decision-making. Property in the vicinity of the waste sources associated with Phases I and II of the Silver Creek Drainage Project are primarily private lands consisting of patented mining claims. The Antiquities Act is applicable only to state lands, but is relevant and appropriate in decision-making affecting other properties. Heritage property is defined in § 22-3-421, MCA, as any district, site, building, structure, or object located upon or beneath the earth or under water that is significant in American history, architecture, archaeology, or culture.

Section 22-3-433, MCA, (Relevant and Appropriate) requires that evaluation of environmental impacts include consultation with the historic preservation officer concerning the identification and location of heritage properties and paleontological remains on lands that may be adversely impacted by the proposed action. The responsible party, in consultation with the historic preservation officer and the preservation review board, shall include a plan for the avoidance or mitigation of damage to heritage properties and paleontological remains to the greatest extent practicable. (Applicable only to state lands, but is relevant and appropriate in decision-making affecting other properties).

Section 22-3-435, MCA, (Relevant and Appropriate) requires any person conducting activities, including survey, excavation or construction, who discovers any heritage property or paleontological remains or who finds that an operation may damage heritage properties or paleontological remains shall promptly report to the historic preservation officer the discovery of such findings and shall take all reasonable steps to ensure preservation of the heritage property or paleontological remains. (Applicable only to state lands, but is relevant and appropriate in decision-making affecting other properties).

<u>Cultural Resources Regulations</u>

ARM 12.8.503 through 12.8.508 (Relevant and Appropriate) prescribe specific procedures to be followed to ensure adequate consideration of cultural values in agency decision-making.

## 3.3 MONTANA ACTION-SPECIFIC ARARS

### 3.3.1 Water Quality Act (Applicable)

Section 75-5-605, MCA, makes it unlawful to cause pollution of any state waters or to place or cause to be placed any wastes in a location where they are likely to cause pollution of any State waters.

<u>Surface Water Quality Standards (Applicable)</u>

ARM 17.30.610 (1) (Applicable) provides that specified waters in the Missouri River drainage, including the Silver Creek drainage, are classified B-1 for water use.

The standards for B-1 classification waters are contained in ARM 17.30.623 (Applicable) of the Montana Water Quality regulations. These standards place limits on fecal coliform content, dissolved oxygen concentration, pH balance, turbidity, water temperature, sediments, solids, oils and color. Concentrations of toxic or deleterious substances which would remain in the water after conventional treatment cannot exceed applicable standards set forth in department Circular WQB-7.

Additional restrictions on any discharge to surface waters are included in:

> ARM 17.30.635 (Applicable), which requires that industrial waste must receive, as a minimum, treatment equivalent to the best practicable control technology currently available (BPCTCA) as defined in 40 CFR Subchapter N and subsequent amendments. Industrial waste is defined in Section 75-5-103, MCA as any waste substance from the process of business or industry or from the development of any natural resource, together with any sewage that may be present. ARM 17.30.635 also requires that in designing a disposal system, stream flow dilution requirements must be based on the minimum consecutive 7-day average flow which may be expected to occur on the average of once in 10 years.

ARM 17.30.637 (Applicable), which prohibits discharges containing substances that will:

(a) settle to form objectionable sludge deposits or emulsions beneath the water's surface or upon adjoining shorelines;

(b) create floating debris, scum, a visible oil film (or be present in concentrations at or in excess of 10 milligrams per liter) or globules of grease or other floating materials;

(c) produce odors, colors or other conditions which create a nuisance or render undesirable tastes to fish flesh or make fish inedible;

(d) create concentrations or combinations of materials which are toxic or harmful to human, animal, plant or aquatic life; or

(e) create conditions which produce undesirable aquatic life.

ARM 17.30.637(4) and (10) also provide that leaching pads, tailing ponds, water, waste, or product holding facilities must be located, constructed, operated, and maintained to prevent any discharge, seepage, drainage, infiltration, or flow which may result in pollution of state waters. A monitoring system may be required to ensure such compliance. No pollutants may be discharged and no activities may be conducted which, either alone or in combination with other wastes or activities, result in the total dissolved gas pressure relative to the water surface exceeding 110 percent of saturation. The rule also sets out other general prohibitions one should review for any site specific conditions.

ARM 17.30.505-508 provides that discharges to surface waters and groundwaters may be granted a mixing zone on a case by case basis by the DEQ in accordance with its written implementation policy. In granting a mixing zone, the department shall ensure (1) surface water and ground water quality human health and aquatic life standards must not be exceeded beyond the mixing zone; (2) discharges to wetlands (other than constructed wetlands) will not be granted a mixing zone for parameters for which the state has adopted numeric acute or chronic standards for aquatic life or for human health in the surface water quality standards unless (a) the standards will not be exceeded beyond the boundaries of the mixing zone, (b) existing beneficial uses will not be threatened or harmed; and (c) the conditions in 75-5-303(3), MCA are met; (3) for discharges to surface water that first pass through the ground, such discharges from infiltration systems or land application areas, the surface water mixing zone begins at the most upstream point of discharge into the receiving surface water. If the discharge continues to occur downstream beyond a distance equal to 10 times the stream width measured at the upstream discharge point at low flow, a standard mixing zone will not be granted and (4) no mixing zone for groundwater will be allowed if the zone of influence of an existing drinking water supply well will intercept the mixing zone.

ARM 17.30.1203 (Applicable), which adopts and incorporates the provisions of 40 CFR Part 125 for criteria and standards for the imposition of technology-based treatment requirements in MPDES permits. Although the permit requirement would not apply to on-site discharges, the substantive requirements of Part 125 are applicable, i.e., for toxic and nonconventional pollutants treatment must apply the best available technology (BAT) economically achievable; for conventional pollutants, application of the best conventional pollutant control technology (BCT) is required. Where effluent limitations are not specified for the particular industry or industrial category at issue, BAT/BCT technology-based treatment requirements are determined on a case by case basis using best professional judgment (BPJ). See CERCLA Compliance with Other Laws Manual, Vol. I, August 1988, p. 3-4 and 3-7.

The Water Quality Act and regulations also include nondegradation provisions (17.30.701 et seq.) which require that waters which are of higher quality than the applicable classification be maintained at that high quality, and discharges which would degrade that water are prohibited. Montana's standard for nondegradation of water quality is applicable for all constituents for which pertinent portions of the Silver Creek are of higher quality than the B-1 classification. If any remedial action constitutes a new source of pollution or an increased source of pollution, the nondegradation standard requires the degree of waste treatment necessary to maintain the existing water quality for constituents that are of higher quality than the applicable classification. Categories of activities that cause non-significant changes in water quality are described in ARM 17.30.716. Informational requirements for non-degradation significance/authorization review, department procedures, and criteria for determining non-significant changes in water quality are presented in ARM 17.30.706-715.

The MPDES permit requirements are technically not applicable to remedial actions at CERCLA sites because ARM 16.20.1305(3) exempts "Any discharge in compliance with the instructions of an on-scene coordinator pursuant to 40 CFR Part 300 et seq. (the NCP)." This exemption is even broader than the 121(e) permit exemption, because it would apply even to an off-site discharge, if such discharge were "in compliance with the instructions of the OSC." The MPDES requirements could still be relevant and appropriate to discharges of pollutants as part of a remedial action. However, it would probably be more appropriate to identify the federal requirements as the relevant and appropriate requirements because of the express state exemption, which arguably represents a determination that the state MPDES requirements are not relevant or appropriate. Note that this analysis does not apply to a site being addressed only under CECRA and not CERCLA, because the exemption applies only to the instructions of an OSC under the NCP.

The MPDES standards (the substantive requirements to be enforced through the permitting process) are set out in 17.30.1203, et seq. These standards are all simply incorporation of the federal regulations, some of which are included as ARARs, for example:

> ARM 17.30.1206 (Relevant and Appropriate) adopts and incorporates language for toxic pollutant effluent standards found in 40 CFR Part 129.

ARM 17.30.1207 (Relevant and Appropriate) adopts and incorporates language for effluent limitations and standards of performance found in 40 CFR Subchapter N (Parts 401-471, except Part 403).

ARM 17.30.1208 (Relevant and Appropriate) adopts and incorporates language for hazardous substances found in 40 CFR Part 116.

ARM 17.30.1209 (Relevant and Appropriate) adopts and incorporates language for minimum treatment requirements for secondary treatment or the equivalent for publicly owned treatment works (POTW's) and for certain industrial categories found in 40 CFR Part 133.

### 3.3.2 Montana Groundwater Act

Montana Groundwater Pollution Control System (Applicable)

ARM 17.30.1006 (Applicable) classifies groundwater into Classes I through IV based on the present and future most beneficial uses of the groundwater and establishes groundwater classification standards. Groundwater is classified based on the natural specific conductance of the water (ARM 17.30.1005). Class I is the highest quality class; class IV the lowest. ARM 17.30.1006 provides that Class I groundwaters have a specific conductance (SC) of less than 1,000 microSiemens/cm at 25° C. The SC of groundwater, including limited adit water sampling, in the Silver Creek Drainage Project area ranges from 163 to 605 microSiemens/cm.

ARM 17.30.1011 (Applicable) provides that any groundwater whose existing quality is higher than the standard for its classification must be maintained at that high quality in accordance with 75-5-303, MCA and ARM Title 17, Chapter 30, Subchapter 7.

### 3.3.3 Clean Air Act

Air Quality Regulations (Applicable)

Dust suppression and similar actions may be necessary to control the release of substances into the air as a result of earth moving and transportation of mine/mill wastes both off- and on-site. The ambient air standards for specific contaminants and for particulates are set forth in the federal contaminant-specific section above. The levels of certain substances that may not be exceeded are identified in the Air Quality section of the contaminant-specific State ARARs. Additional air quality regulations under the state Clean Air Act, §§ 75-2-101 et seq., MCA, are discussed below.

ARM 17.8.222 (Applicable) specifies that no person shall cause or contribute to concentrations of lead in the ambient air which exceed the following: 90-day average--1.5 micrograms per cubic meter of air, 90-day average, not to be exceeded.

ARM 17.8.604 (Applicable) lists certain wastes that may not be disposed of by open burning, including oil or petroleum products, RCRA hazardous wastes, chemicals, and treated lumber and timbers. Any waste which is moved from the premises where it was generated and any trade waste (material resulting from construction or operation of any business, trade, industry or demolition project) may be open burned only in accordance with the substantive requirements of

17.8.611 or 612. Open burning means combustion of any material directly in the open air without a receptacle, or in a receptacle other than a furnace, multiple chambered incinerator or wood waste burner, ARM 17.8.601(7).

ARM 17.8.308 (Applicable) states that no person shall cause or authorize the production, handling, transportation or storage of any material unless reasonable precautions are taken to control emissions of airborne particulate matter.

ARM 17.8.304 (Applicable) states that "no person may cause or authorize emissions to be discharged in the outdoor atmosphere...that exhibit an opacity of twenty percent (20 percent) or greater averaged over six consecutive minutes."

ARM 17.8.324 (Applicable) prohibits storage tanks for any crude oil, gasoline, or certain petroleum distillates of more than 65,000 gallons capacity unless it conforms to the requirements of this section.

### 3.3.4 Solid Waste Management Act

Several regulations promulgated under the Solid Waste Management Act, §§ 75-10-201 et seq., MCA, and the Hazardous Waste Management Act, §§ 75-10-401 et seq., MCA, are discussed in the federal section of ARARs, because they implement those federal programs in the State. The Solid Waste Management Act was significantly revised in the 1995 Montana Legislature.

Solid Waste Management Regulations

ARM 17.50.504 (Applicable) restricts the types of wastes that disposal sites may handle.

ARM 17.50.505 (Applicable) sets forth standards that all solid waste disposal sites must meet.

ARM 17.50.508 (Relevant and Appropriate) is the provision that establishes the solid waste management system license application. Although a license would not be required for remedial activity conducted entirely on site, the information required by this section is relevant and appropriate.

ARM 17.50.509 (Applicable) sets forth that every proposed solid waste management system must be evaluated, taking into consideration the physical characteristics of the disposal site, the types and amount of waste, the operation and maintenance plan for the system, and the plan for reclamation and the land's ultimate use.

ARM 17.50.510 and 17.50.511 (Applicable) set forth the general and specific operation and maintenance requirements for solid waste management systems.

ARM 17.50.523 (Applicable) specifies that solid waste must be transported in such a manner as to prevent its discharge, dumping, spilling, or leaking from the transport vehicle.

### 3.3.5 Hazardous Waste Management Act (Relevant and Appropriate)

ARMs 17.54.111, 17.54.112 and 17.54.119 (Relevant and Appropriate) establish permit conditions, including monitoring, record keeping requirements, operation and maintenance requirements, sampling and monitoring requirements, and the option for DEQ to establish additional permit conditions on a case-by-case basis.

ARMs 17.54.130 and 17.54.131 (Relevant and Appropriate) state the required contents of a Hazardous Waste Management (HWM) permit application. The information and substantive requirements of these provisions are relevant and appropriate.

ARM 17.54.351 (Relevant and Appropriate) gives hazardous waste sampling protocols, testing methods, and analytical procedures.

ARM 17.54.401 through 17.54.418 and 17.54.501 through 17.54.527 (Relevant and Appropriate) set forth the standards and requirements for generators and transporters of hazardous waste.

ARMs 17.54.701 through 17.54.705 (Relevant and Appropriate) establish hazardous waste management facility standards and requirements.

ARMs 17.54.801 through 17.54.833 (Relevant and Appropriate) set the financial assurance requirements for closure of hazardous waste management facilities.

### 3.3.6 Strip and Underground Mine Reclamation Act

The Silver Creek Drainage Project includes several abandoned hardrock mine/mill sites. Regulations promulgated under Montana's Strip and Underground Mine Reclamation Act §§ 82-4-201 et seq., MCA, provide detailed guidelines for addressing the impacts of mine reclamation activities and earth moving projects and may be relevant and appropriate for addressing these impacts in DEQ-MWCB reclamation projects.

The hydrology regulations promulgated under the Strip and Underground Mine Reclamation Act, §§ 82-4-201 et seq., MCA, provide detailed guidelines for addressing the hydrologic impacts of mine reclamation activities and earth moving projects and may be relevant and appropriate for addressing these impacts in Mine Waste Cleanup Bureau (MWCB) reclamation projects.

ARM 17.24.631 (Relevant and Appropriate) provides that long-term adverse changes in the hydrologic balance from mining and reclamation activities, such as changes in water quality and quantity, depth to groundwater, and location of surface water drainage channels shall be minimized. Water pollution must be minimized and, where necessary, treatment methods utilized. Diversions of drainages to avoid contamination must be used in preference to the use of water treatment facilities. Other pollution minimization devices must be used if appropriate, including stabilizing disturbed areas through land shaping, diverting run-off, planting quickly germinating and growing stands of temporary vegetation, regulating channel velocity of water, lining drainage channels with rock or vegetation, mulching, and control of acid-forming, and toxic-forming waste materials.

ARM 17.24.633 (Relevant and Appropriate) states that all surface drainage from a disturbed area must be treated by the best technology currently available (BTCA). Treatment must continue until the area is stabilized.

ARM 17.24.634 (Relevant and Appropriate) provides that drainage design shall emphasize channel and floodplain pre-mining configuration that blends with the undisturbed drainage above and below and provides specific requirements for designing the reclaimed drainage to:

- meander naturally;
- remain in dynamic equilibrium with the system;
- improve unstable pre-mining conditions;
- provide for floods; and
- establish a pre-mining diversity of aquatic habitats and riparian vegetation.

ARM 17.24.635 through 17.24.637 (Relevant and Appropriate) set forth requirements for temporary and permanent diversions.

ARM 17.24.640 (Relevant and Appropriate) provides that discharge from sedimentation ponds, permanent and temporary impoundments, and diversions shall be controlled by energy dissipaters, riprap channels, and other devices, where necessary, to reduce erosion, prevent deepening or enlargement of stream channels, and to minimize disturbance of the hydrologic balance.

Section 82-4-231, MCA, (Relevant and Appropriate) sets forth that as rapidly, completely and effectively as the most modern technology and the most advanced state of the art will allow, each operator shall reclaim and revegetate the land affected by his operation. The operator must grade, backfill, topsoil, reduce highwalls, stabilize subsidence, and control water. In so doing all measures must be taken to eliminate damage from soil erosion, subsidence, land slides, water pollution, and hazards dangerous to life and property.

In addition, this section directs the operator to employ various specific reclamation measures such as:

- burying under adequate fill all toxic materials, shale, minerals, or any other material determined by DEQ to be acid producing, toxic, undesirable, or creating a hazard;
- impounding, draining, or treating all run-off waters so as to reduce soil erosion, damage to grazing and agricultural lands, and pollution of surface and subsurface waters;
- stockpiling and protecting all mining and processing wastes from erosion until these wastes can be disposed of according to the provisions of this part;
- minimizing disturbances and adverse impacts of the operation on fish, wildlife, and related environmental values;
- minimizing disturbances to surface and groundwater systems by avoiding acid or other toxic mine drainage by such measures as, but not limited to, preventing or removing water from contact with toxic-producing deposits and treating drainage to reduce toxic content which adversely affects downstream water upon being released to water courses; and

- stabilizing and protecting all surface areas, including spoil piles to effectively control air pollution.

Section 82-4-233, MCA, (Relevant and Appropriate) provides that after grading, the operator must plant vegetation that will yield a diverse, effective, and permanent vegetative cover of the same seasonal variety native to the area and capable of self-regeneration. The vegetative cover must be capable of:

- feeding and withstanding grazing pressure from a quantity and mixture of wildlife and livestock;
- regenerating under the natural conditions prevalent at the site; and
- preventing soil erosion to the extent achieved before the operation.

ARM 17.24.501 (Relevant and Appropriate) gives general backfilling and final grading requirements.

ARM 17.24.519 (Relevant and Appropriate) provides that an operator may be required to monitor settling of regraded areas.

ARM 17.24.638 (Relevant and Appropriate) specifies sediment control measures to be implemented during operations.

ARM 17.24.641 (Relevant and Appropriate) sets forth methods for prevention of drainage from acid- and toxic-forming spoils into ground and surface waters.

ARM 17.24.642 (Relevant and Appropriate) prohibits permanent impoundments with certain exceptions and sets standards for temporary and permanent impoundments.

ARM 17.24.643 through 17.24.646 (Relevant and Appropriate) provide for groundwater protection, groundwater recharge protection, and surface and groundwater monitoring.

ARM 17.24.649 (Relevant and Appropriate) prohibits the discharge, diversion, or infiltration of surface and groundwater into existing underground mine workings.

ARM 17.24.701 and 17.24.702 (Relevant and Appropriate) require that during the removal, redistributing, and stockpiling of soil (for reclamation):

- The operator shall limit the area from which soil is removed at any one time to minimize wind and water erosion, and the operator shall take other measures, as necessary, to control erosion.
- Regraded areas must be deep-tilled, subsoiled, or otherwise treated to eliminate any possible slippage potential, to relieve compaction, and to promote root penetration and permeability of the underlying layer. This preparation must be done on the contour whenever possible and to a minimum depth of 12 inches.
- The operator shall, during and after redistribution, prevent, to the extent possible, spoil and soil compaction; protect against soil erosion, contamination, and degradation; and minimize the deterioration of biological properties of the soil.

- Redistribution must be done in a manner that achieves approximate uniform thickness consistent with soil resource availability and appropriate for the post-mining vegetation, land uses, contours, and surface water drainage systems.

- Redistributed soil must be reconditioned by subsoiling or other appropriate methods.

ARM 17.24.703 (Relevant and Appropriate) requires that when using materials other than, or along with, soil for final surfacing in reclamation, the operator must demonstrate that the material: 1) is at least as capable as the soil of supporting the approved vegetation and subsequent land use; and 2) the medium must be the best available in the area to support vegetation. Such substitutes must be used in a manner consistent with the requirements for redistribution of soil in ARM 17.24.701 and 702.

ARM 17.2.711 (Relevant and Appropriate) requires that a diverse, effective, and permanent vegetative cover of the same seasonal variety native to the area of land to be affected shall be established except on road surfaces and below the low-water line of permanent impoundments. Vegetative cover is considered of the same seasonal variety if it consists of a mixture of species of equal or superior utility when compared with the natural (or pre-existing) vegetation during each season of the year.

ARM 17.24.713 (Relevant and Appropriate) provides that seeding and planting of disturbed areas must be conducted during the first appropriate period for favorable planting after final seedbed preparation but may not be more than 90 days after soil has been replaced.

ARM 17.24.714 (Relevant and Appropriate) requires use of mulch or cover crop or both until an adequate permanent cover can be established. Use of mulching and temporary cover may be suspended under certain conditions.

ARM 17.24.716 (Relevant and Appropriate) establishes the required method of revegetation and provides that introduced species may be substituted for native species as part of an approved plan.

ARM 17.24.717 (Relevant and Appropriate) give requirements for tree planting if necessary to comply with MCA 82-4-233.

ARM 17.24.718 (Relevant and Appropriate) requires the use of soil amendments and other means such as irrigation, management, fencing, or other measures if necessary to establish a diverse and permanent vegetative cover.

ARM 17.24.719 (Relevant and Appropriate) prohibits livestock grazing on reclaimed land until the seedlings are established and can sustain managed grazing.

ARM 17.24.721 (Relevant and Appropriate) specifies that rills or gullies deeper than nine inches must be stabilized. In some instances, more shallow rills and gullies must be stabilized.

ARM 17.24.723 (Relevant and Appropriate) provides that the operator shall conduct approved periodic monitoring of vegetation, soils and wildlife.

ARM 17.24.724 (Relevant and Appropriate) provides that revegetation success must be measured by approved, unmined, reference areas. There shall be at least one reference area for each plant community type. Required management for these reference areas is set forth.

ARM 17.24.726 (Relevant and Appropriate) sets forth the required methods for measuring productivity of revegetated areas.

ARM 17.24.728 (Relevant and Appropriate) sets forth requirements for the composition of vegetation on reclaimed areas.

ARM 17.24.730 and 17.24.731 (Relevant and Appropriate) provide that the revegetated area must furnish palatable forage in comparable quantity and quality during the same grazing period as the reference area. If toxicity to plants or animals is suspected, comparative chemical analyses may be required.

ARM 17.24.733 (Relevant and Appropriate) provides additional requirements and measurement standards for trees, shrubs, half-shrubs, and other woody plants.

ARM 17.24.751 (Relevant and Appropriate) mandates specific measures that must be undertaken or actions that must be refrained from to enhance or prevent harm to fish, wildlife, and related environmental values.

ARM 17.24.761 (Relevant and Appropriate) specifies measures that must be implemented to control fugitive dust emissions during certain mining and reclamation activities. Such measures would be relevant and appropriate requirements to control fugitive dust emissions during excavation, earth moving, and transportation activities conducted as part of the remedy at the site.

### 3.3.7 Natural Streambed and Land Preservation Act (Applicable)

Section 75-7-102, MCA, and ARM 36.2.410 (Applicable), which place limitations on and specify criteria to be considered in approving projects affecting streambeds, would be applicable (substantive provisions only) if alternative developed alters or affects a streambed.

## 3.4 OTHER MONTANA LAWS

The following "other laws" are included here to provide a reminder of other legally applicable requirements for actions being conducted at the site. They do not purport to be an exhaustive list of such legal requirements, but are included because they set out related concerns that must be addressed and, in some cases, may require some advance planning. They are not included as ARARs because they are not “environment or facility siting laws” and they are not subject to ARAR waiver provisions.

The administrative/substantive distinction used in identifying ARARs applies only to ARARs and not to other applicable laws. Thus even the administrative requirements (e.g., notice requirements) of these other laws must be complied with in this action. Similarly, fees that are based on something other than issuance of a permit are applicable.

### 3.4.1 Montana Safety Act (Applicable)

Sections 50-71-201, 202 and 203, MCA, state that every employer must provide and maintain a safe place of employment, provide and require use of safety devices and safeguards, and ensure that operations and processes are reasonably adequate to render the place of employment safe. The employer must also do every other thing reasonably necessary to protect the life and safety of its employees. Employees are prohibited from refusing to use or interfering with the use of safety devices.

### 3.4.2 Employee and Community Hazardous Chemical Information Act (Applicable)

Sections 50-78-201, 202, and 204, MCA, state that each employer must post notice of employee rights, maintain (at the work place) a list of chemical names of each chemical in the work place, and indicate the work area where the chemical is stored or used. Employees must be informed of the chemical at the work place and trained in the proper handling of the chemicals.

### 3.4.3 Water Rights (Relevant and Appropriate)

Section 85-2-101, MCA, declares that all waters within the State are the state's property, and may be appropriated for beneficial uses. The wise use of water resources is encouraged for the maximum benefit to the people and with minimum degradation of natural aquatic ecosystems.

Parts 3 and 4 of Title 85, MCA, set out requirements for obtaining water rights and appropriating and utilizing water. All requirements of these parts are laws which must be complied with in any action using or affecting waters of the state. Some of the specific requirements are set forth below.

Section 85-2-301, MCA, of Montana law, provides that a person may only appropriate water for a beneficial use.

Section 85-2-302, MCA, specifies that a person may not appropriate water or commence construction of diversion, impoundment, withdrawal or distribution works therefore except by applying for and receiving a permit from the Montana Department of Natural Resources and Conservation (DNRC). While the permit itself may not be required under federal law, appropriate notification and submission of an application should be performed and a permit should be applied for in order to establish a priority date in the prior appropriation system. A 1991 amendment imposes a fee of $1.00 per acre foot for appropriations of groundwater, effective until July 1, 1993.

Section 85-2-306, MCA, specifies the conditions on which groundwater may be appropriated, and, at a minimum, requires notice of completion and appropriation within 60 days of well completion.

Section 85-2-311, MCA, specifies the criteria which must be met in order to appropriate water and includes requirements that:

1. there are unappropriated waters in the source of supply;
2. the proposed use of water is a beneficial use; and
3. the proposed use will not interfere unreasonably with other planned uses or developments.

Section 85-2-402, MCA, specifies that an appropriator may not change an appropriated right except as provided in this section with the approval of the DNRC.

Section 85-2-412, MCA, provides that, where a person has diverted all of the water of a stream by virtue of prior appropriation and there is a surplus of water, over and above what is actually and necessarily used, such surplus must be returned to the stream.

### 3.4.4 Groundwater Act

Section 85-2-516, MCA, states that within 60 days after any well is completed a well log report must be filed by the driller with the DNRC and the appropriate county clerk and recorder.

### 3.4.5 Water Well Contractors, §§ 37-43-101 et seq., MCA

ARM 36.21.402 provides that any person who drills or otherwise constructs water wells must have a State license.

ARM 36.21.403, 36.21.405, 36.21.406 and 36.21.411 provide requirements for obtaining a license, contents of an application and bonding requirements.

### 3.4.6 Well Construction Standards

ARM 36.21.635 through 36.21.680 set forth water well construction criteria, public water supply wells criteria, well location requirements, and reporting requirements.

ARM 36.21.701 and 36.21.703 specify that monitoring well constructors must be licensed and must verify their experience.

### 3.4.7 Occupational Health Act of Montana, §§ 50-70-101 et seq., MCA

ARM 17.74.101 provides that no worker shall be exposed to noise levels in excess of the following values (expressed in decibels measure on the A-weighting network (dbA)):

Continuous or Intermittent Noise Exposures

| Duration per Day (in hours) | Noise Level (dbA) |
|---|---|
| 8 | 90 |
| 6 | 92 |
| 4 | 95 |
| 3 | 97 |
| 2 | 100 |
| 1-½ | 102 |
| 1 | 105 |
| ¾ | 107 |
| ½ | 110 |
| ¼ | 115 |

These values apply to the total time of exposure per working day regardless of whether or not this is one continuous exposure or a number of short-term exposures. If a worker is exposed to noise levels in excess of these values, feasible administrative or engineering controls must be used by the employer to reduce nose levels. If these controls are inadequate, the employer must provide personal hearing protective equipment to achieve the foregoing maximum permissible noise exposure levels. This regulation is applicable only to limited categories of workers and for most workers the similar federal standard in 29 CFR § 1910.95 applies.

ARM § 17.74.102 addresses occupational air contaminants. This rule establishes maximum threshold limit values for air contaminants under which it is believed that nearly all workers may be repeatedly exposed day after day without adverse health effects. In accordance with this rule, no worker shall be exposed to air contaminant levels in excess of the threshold limit values listed in the regulation. This regulation is applicable only to limited categories of workers and for most workers the similar federal standard in 29 CFR § 1910.1000 applies.